The Dock & Harbour Authority

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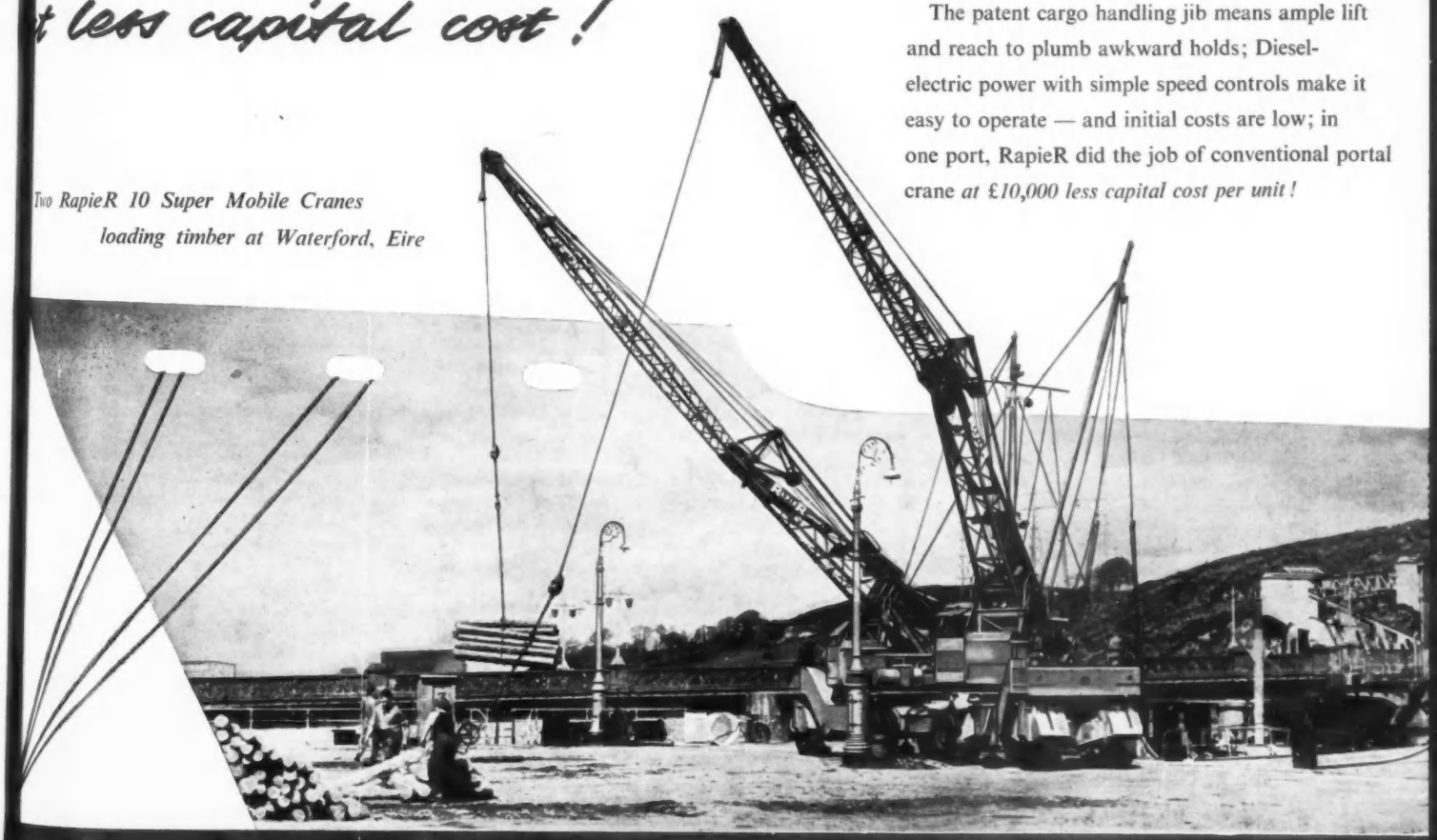

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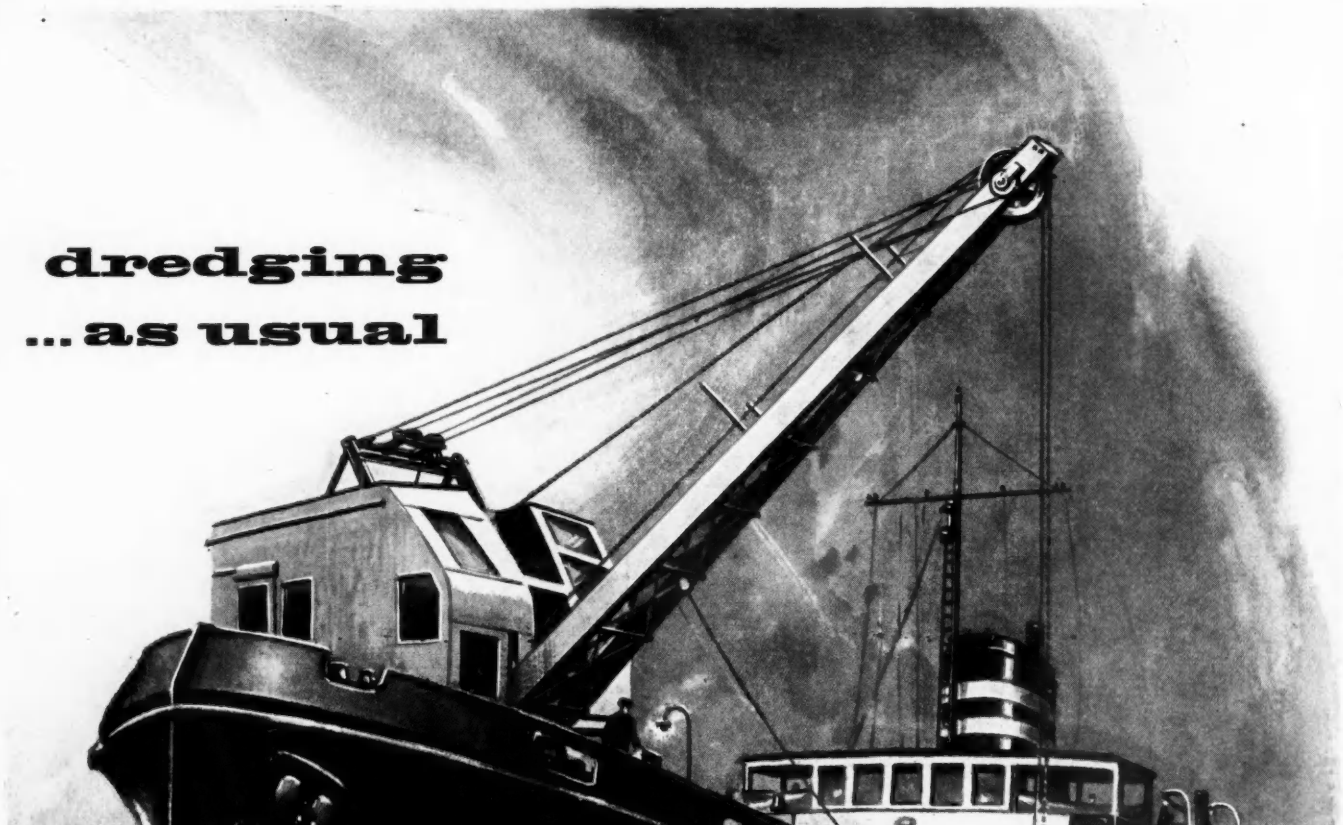

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Editorial Notes

Seasonal Greetings

The Editor and Staff of "The Dock & Harbour Authority" take this opportunity to send to all their readers sincere Christmas Greetings and all Good Wishes for the New Year

The Port of Copenhagen

Readers of this Journal will recall that, in our issue for September last, we called attention to the Centenary of the Port of Copenhagen and referred to the Act of the 30th December, 1858, which established the Harbour Board and so gave the port an independence which would not have been possible under the previous administration.

Standing on the Danish archipelago and having a practically tideless harbour, Copenhagen enjoys a number of natural advantages of which the Harbour Board has taken full advantage. The port is widely known for its entrepôt business and is celebrated for its Free Port facilities.

The leading article for this month, which has been kindly contributed by Mr. J. G. Rode, the Chief Engineer of the Port, gives an informative technical description of the port and an interesting account of the extensive engineering works which have been carried out during the past 100 years.

The Recent Boycott

Has the boycott of flag-of-convenience ships, which was in operation from December 1st to December 4th, had any effect? Has it contributed in any way towards a solution of the problem? It is the answer to these questions rather than the conflicting reports about the "success" of the boycott which is of importance. The International Transport Workers' Federation asserts that something like 200 vessels in ports throughout every continent were directly hit by the boycott action and that a number of other Panhonlib ships sailed at reduced speeds to avoid entering port and being immobilised. According to Mr. Omer Becu, the secretary-general of the International Transport Workers' Federation, the boycott was more successful than expected.

In a long statement issued while the boycott was still in its closing stages, the federation analysed the position as it then was and gave details, necessarily incomplete, of the number of ships which had been held up. It reported, too, the legal action taken in different countries which prevented dockers and seafarers from joining in the boycott or, as was the case in the United States of America, gave them freedom to do so.

On the other hand, Sir Richard Snedden, the secretary of the International Shipping Federation, which opposed the boycott because of its ineffectiveness, described the response as being in the main lukewarm, with large areas of the world untouched.

The I.T.W.F. do not seem to appreciate the attitude taken up by the shipowners of the traditional maritime countries and criticise the International Shipping Federation for not supporting them in the boycott. They state that they have at no time suggested that a boycott would solve the problem of "runaway" ships flying foreign flags. On the contrary, they have repeatedly said that such a solution could only be found at Government level. They are only concerned with the protection of adequate labour standards on these ships and they regard the refusal of the shipowners to conclude collective agreements as inexcusable.

"Under existing circumstances," says an official statement issued from the I.T.W.F. London headquarters, "logic would seem to require that the shipowners of bona fide maritime countries where such collective bargaining agreements already exist —a group including the members of the International Shipping Federation— should support us in this action."

It may be recalled that one of the reasons for the opposition of the International Shipping Federation to the boycott was that it would involve a breach of national collective agreements, and in some cases of national industrial law. They could not agree to the disruption of national industrial agreements by "the action of an international body which is not party to those agreements. Unconstitutional action of this kind," it was added, "might cause grave damage to industrial relations."

It must be appreciated that not all ships flying flags of convenience were under the ban—only those whose owners have no collective agreements recognised by the I.T.W.F. on crew pay and conditions. In these cases the I.T.W.F. have been requiring owners to pay into a special welfare fund something in the neighbourhood of £2 a man per month if they want their ships worked. This is unpalatable to the shipowners concerned and, it is safe to assume, to others as well, because of the dangerous principle involved.

The I.T.W.F. is a responsible body, with British trade union leaders of the calibre of Mr. Tom Yates, general secretary of the National Union of Seamen, and Mr. T. O'Leary, national secretary of the docks groups of the Transport and General Workers' Union, taking a prominent part in the organisation of the boycott. The concern of the Federation is long-term. Excellent as may be the standards in most flag-of-convenience ships in good times, it is argued that without collective agreements the seafarers will be defenceless in times of depression. It is for this reason that the Federation require flag-of-convenience operators to pay into their special welfare fund.

There have been two developments and the Federation claims that both were either the outcome of the boycott or were associated with it. First, Greek shipowners have made an agreement with the Greek seamen's union providing that crews of Greek-owned ships registered in flag-of-convenience countries will have collective labour agreements and also benefit from the insurance and protection afforded by Greek law. Second, Costa Rica has removed itself from the category of a flag-of-convenience country by the cancellation of registration of foreign-owned ships.

There is one further point. The four-day boycott is not

Editorial Notes—continued

necessarily the end of the I.T.W.F. protest movement. It has been stated that the boycott will be resumed with a number of sporadic outbreaks. The Fair Practices Committee of the Federation were due to meet in the middle of December to consider future action. The psychological aspect, too, must be considered. Charterers may conceivably become nervous of committing themselves to ships which may be subject at a moment's notice to delay. Thus, the boycott as such may not have achieved much, beyond publicity, but its possible repercussions could be serious.

Preferential Delivery Scheme for Manchester

From January 1st next, the Manchester Ship Canal Company are to introduce a new scheme which will give preference to pre-advised vehicles arriving at the docks between specified hours, to collect imported goods.

In April, 1957, the company set up a Quay Delivery Bureau to enable importers, agents and haulage contractors to give advance notice of their intention to collect traffic from the Manchester Docks. The main object of the scheme was to enable the ship canal company to have the men and mechanical equipment available in the right places at the right time and the Bureau has now become an integral part of the docks organisation.

With a view to extending the functions of the Bureau, the company sought the advice of local commercial interests and it was finally decided to introduce an experimental scheme, subject to review after six months of operation, under which some preference would be given to pre-advised vehicles arriving between specified hours during the morning and afternoon.

The company invites users of the docks to co-operate on this new scheme by telephoning their requirements before 4 p.m. on the day before the intended date of collection and at the same time saying whether the vehicles will arrive between 8 and 10 a.m. or 1 and 2 p.m. Vehicles advised for arrival within one or other of these periods and duly showing up on time at the appropriate delivery points will receive preferential attention over any unadvised vehicles already in attendance at the berth. The company adds that they will give guidance on how many vehicles can be dealt with and the best time to send them. The scheme does not cover deliveries of traffic imported in certain short-sea and coasting services.

It is well known in the port industry that one of the principal causes of slowness in the turn-round of shipping is the delay experienced in collecting inward cargoes, which leads to congestion on the quays and in the sheds. This scheme, which is claimed to be the first of its kind in any U.K. port, should effect an improvement, but what success it will have in practice is yet to be seen. It will be interesting to observe the reactions of the drivers of unadvised vehicles which are forced out of their place in the queue. In this connection, it is essential that the scheme should be given the widest publicity, so that all may know its terms.

Proposed New Tanker Terminal for Southampton

Formal approval has been given by the Southampton Harbour Board to a proposal, submitted by engineering consultants on behalf of the Caltex Group of companies, for the construction of a marine terminal for berthing oil tankers in Southampton Water. The terminal will consist of an L-shaped jetty, 1,000-ft. long, about three-quarters of a mile south of the mouth of the River Hamble. It will be connected to the shore by a trestle 3,300-ft. long.

Readers of these columns will recall that in our February, 1958, issue, we described the full scale tidal model of Southampton Water which was constructed to test the possibilities of this scheme and to decide the location and alignment of the jetty. Caltex have now presented this model to Southampton University where in future it will be used to carry out more general investigations on Southampton Water than have hitherto been possible. Approval by the Harbour Board of this new refinery scheme, which will involve an expenditure of between £25 and £30 million, takes a stage further the proposal for a second oil refinery in Southampton Water, about which there has been considerable opposition from yachting interests and residents in the area.

For the past two years negotiations have been taking place between Caltex Ltd., a firm of engineering consultants and a special sub-committee of the Harbour Board and, last December, as a result of experiments on the tidal model, a final scheme was approved. In a statement, the Caltex organisation said the location of the jetty had been selected to comply with requirements of the Board and to permit an easy approach by ships entering the mouth of the river. The jetty head would be located in a dredged area of considerable size to facilitate the approach and departure of vessels. It would provide an outer berth for large tankers and either one inner berth for medium size vessels or two inner berths for smaller vessels. The jetty head would be positioned near Coronation Buoy.

It is understandable that the Solent yachting interests and local inhabitants are reluctant to see what might well become a second Fawley on Southampton Water. Should the Caltex Group continue with their proposals, as now seems probable, it will undoubtedly add to the heavy traffic already using the Solent Water.

New Maritime Commission for Pakistan

It was recently announced that, in order to develop a merchant marine, the Government of Pakistan is to set up a maritime commission with wide terms of reference.

The commission will investigate and recommend measures for the improvement of the Merchant Navy and the Governmental agencies connected with its operations; inspect port facilities, shipbuilding, ship repairs yards and dockyards to meet the requirements of shipping; recommend suitable technical services for the Merchant Navy and allied sectors, including training facilities; and discuss with private organisations the commercial and technical management of merchant shipping.

It will be open to the commission to propose such immediate changes for improving efficiency as may be feasible, during the course of its investigations. The commission will also give consideration to the reorganisation and integration of the various agencies connected with commercial maritime affairs, in order to bring about effective co-ordination and integrated control.

The commission has been invested with adequate powers to obtain factual information and evidence, invite expert advice and recommend improvements which would be capable of implementation on a short-term and long-term basis.

Quay Improvements at Grimsby

British Transport Docks announced during November that the West Quay of the Royal Dock, Grimsby, is to be modernised at a total estimated cost of £165,000. The work provides for the widening of the quay from 36-ft. to 66-ft.; the renewal of the two existing railway lines and the provision of a third; renewal of the crane track and the strengthening of the arches on which the quay is built to allow modern cranes to be used. The whole area will be resurfaced in concrete.

Three new 7½/3-ton electric cranes will be installed in replacement of four hydraulic 3-ton units, and two 3-ton electric cranes will be transferred from the east side of the dock. The quay will then be equipped with seven electric cranes (with lifting capacities ranging from 3 to 10 tons) and with sheerlegs of 60 tons capacity. Hydraulic power will be discontinued, and diesel tractors used in place of capstans.

The West Quay is 1,033-ft. long and is used mainly by cargo liner vessels trading with Norway, Holland and Northern France. Inward cargoes consist of dairy produce and other foodstuffs, wood pulp and wood manufactures; while outward cargoes are chemicals, machinery, vehicles and iron and steel. The work now to be undertaken should facilitate the handling of these traffics and improve the turn-round of ships.

This new scheme follows on a number of improvements to the Royal Docks in recent years. Work is already proceeding on the reconstruction and remodelling of the mineral quay to provide a lorry road to this part of the quay, while an extensive scheme for the reconstruction of the sheds on the west side of the dock is also in progress.

The Port of Copenhagen

Technical Developments during the past Hundred Years

By J. G. RODE (Chief Engineer)

HARBOURS are built to serve the ships, and therefore, of course, they must primarily be developed according to the requirements of shipping. One of the chief difficulties of the harbours is, that while the life of ships is comparatively short—after 30 years a ship is already obsolete—the harbour works are generally of a much more permanent nature and may serve for decades or even for centuries.

The Port of Copenhagen was already old when, in 1858, it became an independent institution. The older parts had more or less been fully developed, but soon it outgrew its boundaries, and the technicians got plenty of opportunity to solve new problems in accordance with modern principles.

Harbour construction is one of the oldest branches of engineering. Hydraulic engineering often has to cope with very great difficulties caused by nature. Heavy waves, violent currents, tide, floods, littoral drift, and ice action, often create grave technical and economic problems. Also the character of the sea-bottom can often give much trouble to the harbour engineer, whether it be strata of mud with almost no bearing capacity, or rock which has to be blasted in order to permit the passage of ships. In Copenhagen we have very few of these difficulties. The engineer may regret not to be faced with such interesting technical tasks, but of course the favourable natural conditions are a great economical asset to the Port of Copenhagen. Indeed, the conditions at our Port are the cause of much envy on the part of harbour specialists elsewhere.

The original harbour area was well protected by the islands "Slotsholmen" and "Amager," and even now, after the harbour has extended far out into the open "Sound," the waves in and immediately outside the port are of very limited height. The current was somewhat troublesome for several years, but that was due to man's interference rather than to Nature: In former times the wide and shallow expanse of water between "Sjælland" and "Amager" greatly reduced the current caused by different water levels in "Koge Bay" to the south and the minor importance to the constructions it must also be mentioned that we have the advantage of being able to reclaim extensive land areas for harbour activity on the many shallow waters on both sides of the harbour.

Most of the harbour works in Copenhagen have, for the above mentioned reasons, been rather simple and inexpensive. Nevertheless, it seems appropriate on the present occasion to give an outline of the technical developments of the harbour constructions as well as the harbour technique in general.

Breakwaters

On account of the sheltered position of the older harbour area breakwaters were unnecessary for a long time. At first only rows of piles were used. From olden times the Naval Harbour was protected in this way at the north side, and in the nineties when the new "Gasværks Harbour" was built piles were driven there in order to subdue the waves entering from the water area to the east, which at that time was rather wide. When the Free Port was established, also in the nineties, the so-called "Free Port Breakwater" (Fig. 1) was built, mainly of concrete blocks; it now forms the northern side of the "Redmole Pier." The breakwaters of the "Outer Harbour" date from the beginning of this century; they were constructed on rather shallow water and chiefly consist of rubble, the pier heads, however, of heavy concrete blocks in bond. The "Stubbe Breakwater" extension from about 1918 was built of caissons of reinforced concrete. One of the reasons for the choice of this construction was the possible necessity of moving the breakwater to another position in connection with future harbour extensions. The more primitive breakwaters to the north of the "Ten Metre Basin," at the "Skude Harbour," and at the "Kalkbrænderi Harbour" all consist of rubble. This is also the case for the breakwaters of the "Provestens Harbour," built in the thirties. The pier heads, though, are reinforced concrete caissons (Fig. 2).

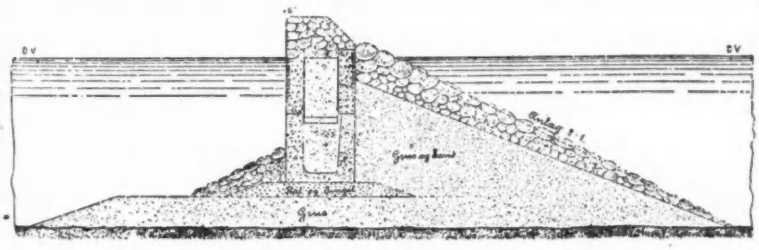


Fig. 1 (above). Breakwater for the Free Port, 1893.

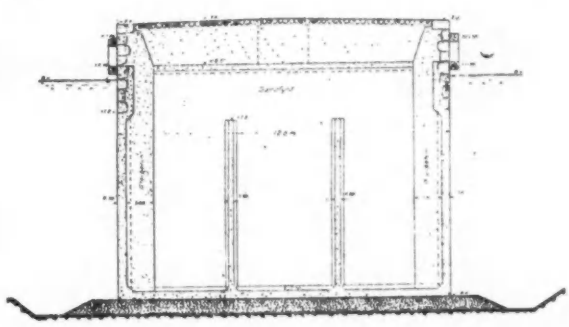


Fig. 2 (right). Caisson for the breakwater head at the "Provestens Harbour," 1936.

"Outer Harbour" to the north, but extensive dredgings together with narrowing of the harbour channels through reclamations along its sides brought about a serious increase in the current. These troubles, however, have been completely overcome through the construction of the dam and the sluices in the "Kalveboderne."

Tide is practically unknown, and although the water level may vary considerably under the influence of strong winds from certain directions it is nothing compared with the variations known in other parts of the world. Typhoons and earthquakes are unknown here, and the small salinity of the water makes it comparatively uncorrosive towards steel and concrete, and the most voracious marine-borers cannot live here. We have no rivers to carry silt and ice, nor coastal currents to deposit sand in the channels. Finally, the bottom has a good bearing capacity, but it is not so hard as to make dredging impracticable. Although of

The Sluices and the Dam in the Kalveboderne

As mentioned above this construction was carried out in 1901 in order to regulate the current in the harbour. The dam was made of earth and provided with sluices between granite piers, built directly on the bottom, and furthermore with a lock having a depth of 3.7 metres above the thresholds. The lock has sliding gates, as the highest water level may occur on both sides. The lock and sluices present a variety of interesting technical details, which, however, are outside the scope of this article.

Water Depths

The growing size of ships has resulted in demands for still greater depths in the harbours. A hundred years ago hardly any quay in the Port of Copenhagen had more than 4.7 metres of water. Only at the "Steamship Pier," the wooden jetty which was later replaced by the "Kvæsthus Pier," there was 5.3

The Port of Copenhagen—continued

metres. The Harbour Plan of 1862 included the dredging of a 6.3 metre channel throughout the whole length of the harbour, and this was carried through in the following years. The channel from the northern entrance, the "Kronlob," to the Custom House was even dredged to −6.9 metres; this was an easy task as the water depth in most places was 7—8 metres. The 7.5 metres deep old "Red Harbour," the present "North Basin," was built in the eighties, and in the Free Port, which dates from the nineties, the most important basin was given a depth of 9.1 metres.

Also in the old harbour the water depths were gradually increased. In the beginning of this century a depth of 8.1 metres was provided at "Larsens Plads" and 7.5 metres through the Inner Harbour to "Islands Brygge." The Free Port extensions during the First World War included the "Kronlob Basin" with 9.5 metres of water, and in 1922 the first section of the "Ten Metre Basin" was completed with a depth of 10 metres in the basin and in the entrance, "Kronlobet."

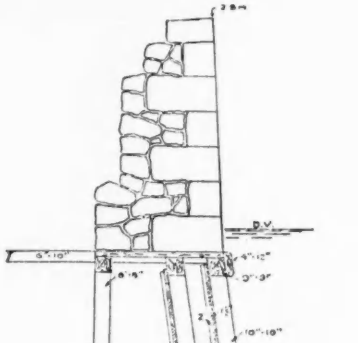
Now, the present maximum depths were reached in the Port proper; it has hitherto proved sufficient for the passenger and cargo ships which can be expected to call here, and it seems improbable that a further deepening should be necessary in the near future. About 1947 a depth of 10 metres was produced along the north side of the "Redmole Pier" as a result of the growing dimensions of tankers.

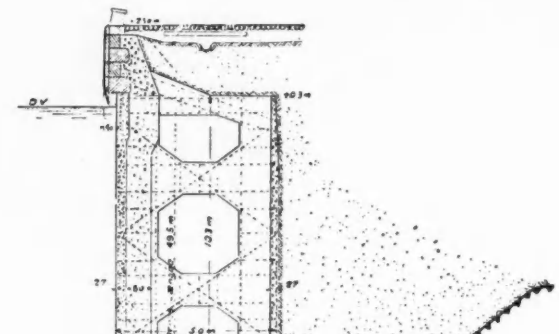
behind the wall. The latter construction was necessary for the stability when the depth exceeded 3—4 metres, and they provided better berths.

The wooden walls had the disadvantage that the part above the water level rotted away in about twenty years. New superstructures were then mortised to the substructures, but gradually the rise in the price of wood and the cost of labour made it desirable to find more permanent constructions. Below water wood does not rot, and therefore wooden walls could be used from the water level and down, while granite walls with smooth front sides were introduced above water (Fig. 3). These walls were not provided with fenders.

Quay walls of this type were built in the seventies at "Slotsholmen" and in the southern part of the Free Port. In both cases the walls were built in the dry behind cofferdams, and the granite extends 0.50 metre below water level. Most of the quay walls built around the turn of the century were of a similar construction.

In the nineties the sewerage system of Copenhagen was altered, and the sewage was from now on carried far out into the "Sound" through pipelines on the sea bottom. The water in the harbour thus became much cleaner, and the result was that teredos could live in the timber of the quay constructions. Some unpleasant surprises showed the necessity of protecting the wood with plating, nails, or creosoting, or to introduce new constructions without timber. Quite a few such types were used in the following years. Some of the oldest quays in the Free Port are massive walls of concrete with granite facing. Similar constructions were used in the "Ten Metre Basin" and at "Teglholmen," both in 1920.





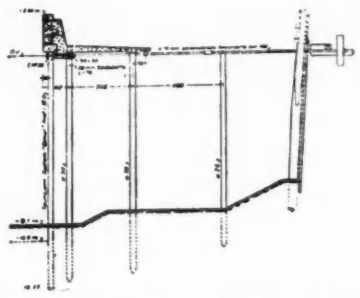


Fig. 3 (left). Quay wall on wooden piles. The "Slotsholms Canal," about 1875.

Fig. 4 (centre). Quay wall of reinforced concrete caissons. The "Kronlobo Basin," 1917.

Fig. 5 (above). Quay wall on a substructure of steel sheet piling.

The special oil harbour, the "Provestenen," was commenced in 1935 with a depth of 9.1 metres, but when the great extension was begun in 1950 it was considered necessary to build the new quays with a depth of 10.5 metres, and also the entrance to the oil harbour was dredged to −10.5 metres. The rapid increase in the size of tankers, however, will indubitably render this depth insufficient in a not too distant future. Of course we can hardly expect super tankers at Copenhagen, and it is also quite unlikely that large oil refineries be established here, but the import of oil will in all probability continue to grow and make it economically desirable to use larger ships than can presently enter the "Provestens Harbour. Fortunately it is possible to dredge a channel of 12 metres in the Sound at a reasonable cost, and this depth can be considered sufficient for a long time. The demands of a distant future are, of course, impossible to anticipate, but a further deepening of the entrance channels to Copenhagen will be so costly an affair as to be economically impracticable.

Quay Constructions

In the middle of the last century wooden quays were prevalent in this port. Only at a few places the harbour builders had permitted themselves the luxury of granite walls.

The wooden quay walls were partly of the old construction, supported by strut piles on the outside, and partly of a more modern type with wooden ties and timber walings in the earth

In 1916-18 the quays at the "Kronlobs Basin" were built. Here the construction of cofferdams was not practicable, and therefore the quay walls were made up of caissons of reinforced concrete (Fig. 4),which were built in a dock and towed to the site; here they were filled with sand and provided with superstructures of concrete with granite facing.

Another system for quay walls is the so-called steel sheet piling, which was used for the first time in the "Kalkbrænderi Harbour" in 1915. This wall is still in existence and can be expected to serve for quite a few years. This type later became by far the most common throughout the port. When the thickness of the steel is more than 10 mm. the life of the sheet piling can be estimated at 70 years.

The steel sheet piling is very useful here because of the nature of the bottom, which often contains stones in the upper layers and limestone or flint further down. Steel sheet piling has been used at depths of up to 10.5 metres (the "Provestens Harbour," 1951). Almost all types of piles have been used, and no decisive reasons have been found for preferring one type to the others. In periods when the price of cement was more favourable than that of steel, quay walls were built of sheet piling of reinforced

The Port of Copenhagen—continued

Fig. 6. Cargo handling on an old quay with ordinary pavement, about 1930.

concrete, i.e. the "Bors Quay," 1934.

Some steel walls and nearly all the quay walls of concrete sheet piling have concrete walls with granite facings above water. The granite mainly serves aesthetical purposes, but in addition to this the walls need no fendering. The anchorage of both types usually consists of tie-rods of round iron with anchor slabs of reinforced concrete.

Sometimes horizontal relieving platforms are placed behind quay walls at great water depths in order to reduce the earth pressure on the walls. An example of this construction is the "Langelinie Quay" from 1934-35 (Fig. 5).

Whether to put the fenders on the quay walls or not has always been a point of discussion. Quay walls of wood and steel usually have fenders, but generally no fenders were put on granite walls. However, the modern welded ships suffer more from the incomplete fendering put out by the ships, and therefore the Port Authority has recently begun to place rubber fenders on the most frequented quays and on those which are particularly exposed to the weather.

In many parts of the world open jetties are used instead of solid quay constructions. In Copenhagen this is the case in the yacht- and fishing-harbours. Far larger ships quay walls are more economical under the favourable conditions in our harbour. At the oil bunkering station on the "Redmolen," however, wooden jetties were built in 1915, as it was unnecessary to provide access for lorries to the ships' sides.

Quay Surfacing

Many ports pay little attention to the quay surfacing, as the greater part of the cargo is handled between ships and railway cars. In Copenhagen railway traffic has always been of minor importance, and since olden times the quays were therefore always paved with granite stones (Fig. 6). Up to 1935 this old-fashioned paving was a quite suitable quay surfacing. It could carry heavy traffic, suffered little from the handling of heavy cargo, it was easy to repair, and was quite satisfactory for horse-carts and lorries, which always move slowly along the quay side. After the introduction of the so-called mobile cranes with small wheels, the fork-lifts, and other mechanical equipment, a much smoother surface is now required than can be obtained with the use of granite pavement.

The "Kvæsthus Pier" in 1938 got a concrete surface similar to that of concrete roads. This paving has been excellent for the traffic, but the maintenance has been somewhat difficult. However, concrete has been much improved in later years, and in 1950 new concrete surfaces were made at "Havnegade" and at the "Kronlob Basin."

A special type of concrete surfacing is the prefabricated Stelcon slabs, first used in Holland. During the past five years such slabs have been used at "Larsens Plads" (Fig. 7), on the "Northern Custom House Quay," and at "Christians Brygge." The slabs are protected with steel angles on the edges and granulated steel in the surface; besides great strength they have the advantage of being easy to adjust in case of setting of the subsoil, but they are rather expensive.

Modern asphalt paving has also been used with success in various places. It is comparatively easy to repair, but is liable to be damaged by heat and oil.

Harbour Equipment

In addition to basins, channels, and quays, a modern harbour needs a great variety of equipment to serve the ships and their cargo. The most conspicuous are usually the cranes. Primitive cranes manoeuvred by hand have been known for a long time, and a few such cranes were already existing in the Port of Copenhagen a hundred years ago. On the whole, loading and unloading were done with primitive means, and for heavy lifts the ships had to carry booms and hand winches. In the seventies mechanical cargo handling equipment began to appear in large ports. The first cranes were steam-powered or hydraulic, but in the nineties electric cranes were introduced. Fortunately the Copenhagen Free Port was just under construction in this period, and electric portal cranes for general cargo were put up at the very beginning, though with a capacity of only 1.5 tons. The general cargo cranes have been developed considerably since then; thus while the old cranes could only travel along the quay, turn and hoist, the jibs of modern cranes can be raised and lowered, which enables them to reach any point within their maximum radius without moving along the rails. The maximum load of the common general cargo cranes in this port is 3 tons, as heavier cargo is so rare that it would not pay to use the more expensive and slower working cranes with greater capacity. Of course, the cranes have been constantly improved and enlarged in order to serve the bigger ships.

Fig. 7. Stelcon slabs facilitate mechanical cargo handling. "Larsens Plads," 1955.

The Port of Copenhagen—continued

In Copenhagen general cargo cranes are mainly found in the Free Port and at "The Southern Custom House" on quays with multi-storied warehouses, i.e. at the places where the greater part of the overseas cargo is handled. On other quays for general cargo the ships' own gear is used, but this too has been considerably improved in later years.

For transport on shore, stacking of goods, loading and unloading of lorries and railway cars, mobile cranes and fork-lifts are used on many places, the latter in connection with pallets and containers. The "Kvæsthus Pier" is the best example of a "crane-less," but highly mechanised quay. Since the last war the United Steamship Company has developed a very efficient cargo handling system, and the adjustable ramps for the side ports are a further help in speeding up the work (Fig. 8). Most of this equipment is privately owned.

Since the nineties bulk cargo too has been handled by cranes. Some of the oldest were the steam cranes put up in 1894 by the municipal gas-works at the "Gasværks Harbour." The Port Authority leaves it to the private importers to put up their own cranes, and consequently a great number of different types have appeared, but common for all is that they are electrically driven and provided with grabs. In addition to cranes, the Free Port and various private firms have pneumatic grain elevators. Also various special equipment is used, such as conveyors for stacked goods and bananas, portable elevators, belt conveyors, etc.

The heavy goods present one of the most precarious problems of the Port. Although many ships have booms for heavy lifts special equipment is often needed. The Port Authority together with the Free Port own a 45 ton gantry crane at the "Ten Metre Basin," and besides the Port has a 40 ton floating crane, which, however, is 87 years old and very much out of date. It will be necessary in the near future to get a 100 or 150 ton floating crane with sufficient height and radius.

Furthermore various auxiliary installations have been provided to serve shipping. Many quays have fresh water hydrants and telephones, and at a few places electric supply is available for ship repairs.

Warehouses and Sheds

Warehouses and other more or less sheltered space for storing of goods in the harbours have existed for centuries. In the Port of Copenhagen we still have the famous warehouses from the Mercantile Epoch both at the "Southern Custom House Quay," at "Asiatisk Plads," and at several other places. These warehouses had simple hoists on the outside, but goods were not stacked to any great height on the various floors. Their solid construction, however, made them very useful for long time storage.

When mechanisation began, the first warehouses in the Free Port (about 1894) were built with loading platforms and with balconies on all floors, which could be reached by cranes. In the Free Port the building of warehouses continued and the newest are Sheds No. 47 and 48 (Fig. 9), and the East Asiatic Company's two buildings at the "Ten Metre Basin," all built after the war. Like their predecessors all have balconies, and the flat roof of Shed No. 48 can be used for light cargo which can be stored in the open.

The floors are now of reinforced concrete, designed for loads of up to 2 tons per sq. m., and can carry fork-lifts, which stack the goods to the ceiling. The newer warehouses have various fire protection installations and can be partly heated.

In the harbour area outside the Free Port the Customs are at present erecting a modern warehouse at the "Southern Custom House Quay," and at the "Northern Custom House Quay" the Port Authority built a small one-storied warehouse in 1951, but on the whole few warehouses have been built during the past one hundred years. Around the turn of the century simple sheds, for instance of corrugated iron, were put up at some places, such as the "Kvæsthus Pier," "Havnegade," and "Christians Brygge." These sheds have been replaced by open quay roofs of reinforced concrete or steel, on the "Kvæsthus Pier" in 1938, at "Havnegade" in 1953, and at "Christians Brygge" in 1953-56. The quay roofs are not suitable for the storing of goods, but they give shelter during loading, unloading and sorting. As a matter of fact, it is essential that the goods pass the harbour area as quickly as possible, while long time storage should take place at some distance from the water front, where sites are cheaper than the quay areas.

It will be appropriate in this connection to mention the buildings for various special purposes erected at the harbour in the course of the years. Buildings for cold storage were erected at

Fig. 8. Ramp giving direct access for fork-lift trucks to ships' hold through side port.

"Christians Brygge" in 1907 (demolished in 1952), and at "Islands Brygge" in 1940. Also in the Free Port there are a number of cold rooms.

Grain and feeding stuffs are generally stored in silos. Among the first buildings in the Free Port was the well-known granary on the "Central Pier", its internal installations having later been modernised several times. About 1903 another granary was built on the "West Quay." Several private firms, too, have erected granaries in the Free Port as well as in the old harbour, and at present silos are under construction at various places. A silo of a somewhat different character has been built on "Sluseholmen" by Aalborg Portland-Cement-Factory (Fig. 10).

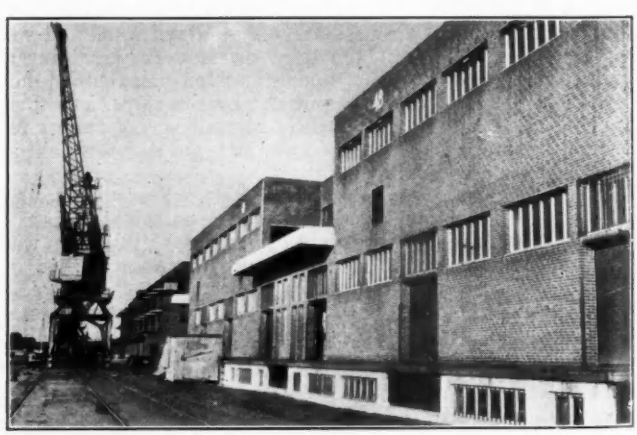


Fig. 9. Sheds No. 47 and 48 in the Free Port, 1957.

Railways

During the last 100 years the rôle of the railways in the freight traffic at first grew to almost complete predominance as regards land transportation beyond the pure local traffic, but in recent years it has declined considerably.

In Copenhagen the first harbour railway was built in 1880 along the old "Gasværks Harbour," the "Christians Brygge," and "Havnegade," and for many years, as a matter of course, all new quays were provided with tracks.

The Port of Copenhagen—continued

The original Free Port included an extensive system of tracks, established by the Free Port Company for its own use, and it is still of great importance. The track from the "Osterport" Station, through the Citadel, to the "Northern Custom House Quay" also dates from the first year of the Free Port, and in 1897 this track was extended to "Larsens Plads."

The new "Kalvebod Brygge" from 1897 was provided with quay tracks, and the bridge "Langebro," completed in 1903, also had tracks, which shortly afterwards were extended along "Islands Brygge." All the new quays built in the period from 1900-1920 included quay tracks.

In the twenties lorries gained ground and soon took over the transport of goods to the city and its surroundings. The original idea of connecting the harbour railway line from the south to "Havnegade" with the northern line to "Larsens Plads" was abandoned, and when the new "Knippelsbro" bridge was built in 1934 the quay tracks in "Havnegade" were removed without much deliberation. Although the net of harbour tracks has been supplemented with lines to the "Provestens Harbour," to the south side of the "Ten Metre Basin," and at various other places, the railway system in the Port of Copenhagen is of a far more modern extent than that of the big foreign ports with wide hinterlands. In the future tracks will probably be needed at certain quays and by some industries in the port, but any significant increase in the railway traffic can hardly be expected. On the contrary, a certain reduction of the existing trackage is more likely.

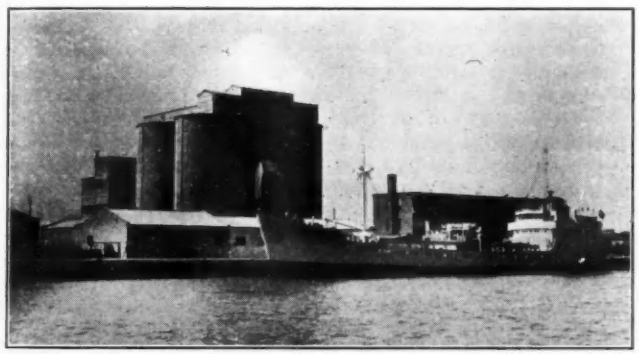


Fig. 10. Storage and packing plant for cement on "Sluseholmen," 1952.

It is therefore impossible to know to-day whether a new railway bridge between "Sjælland" and "Amager" to replace the semi-permanent bridge at the "Langebro" will ever be built, or if the connecting line from the North Harbour to the "Lerso" marshalling yard will ever be realised.

Bridges

The construction and maintenance of bridges across the harbour have always been an important part of the technical activity of the Port Authority. A detailed technical account of the development in this line during the past one hundred years would be too long for this article, and consequently I shall only just mention the most important works.

In 1869 the old wooden bridge "Knippelsbro" was replaced by a steel bridge. A complete renewal took place in 1908, and the present "Knippelsbro" was completed in 1937; it was preceded by a temporary bridge from 1934.

In 1875 the "Langebro" bridge was provided with new bascule leaves of steel, and the bridge was completely renewed in 1903, 1930, and 1954.

The first "Nyhavns Bridge" was built in 1874, and in 1913 it was replaced by the present bridge.

In 1879 a new "Holmens Bridge" and a new "Hojbro" (i.e. High Bridge) were built for the City, followed in 1880 by the two bascule bridges for the harbour railway across the "Bors Canal" and the "Frederiksholms Canal." The latter was replaced in 1936.

In 1883 the "Snorre Bridge" across "Christianshavns Canal" was turned into a bascule bridge. The Free Port from 1892-94 included the big cantilever bridge across the "Osterport" Railway Station, and various smaller bridges.

The narrow foot-bridge across the sluices in the South Harbour was built in 1903 and renewed in 1935.

The reinforced concrete bridge to the "Teglholmen" in the South Harbour and the bridge to the "Benzin Island" in the North Harbour date from the early twenties.

The first bridge to the oil harbour "Provestenen" was built in 1936, and the second in 1954.

Finally, a new road bridge is under construction between "Sjælland" and "Amager," immediately south of the lock in the South Harbour, the bascule leaf being designed and built by the Port Authority for the City.

The Port Authority still runs all the movable bridges across the harbour, although most of them are only partly or not at all owned by the Port.

Lights and Radio

A hundred years ago the Port scarcely had any kind of lights for navigation; as the entrance to the harbour was barred by a boom across the fairway at the Custom House, harbour lights were not needed. In 1867 this method was abandoned, mainly for the benefit of steamers calling at the "Kvæsthus Pier," and lights were put up for the channel. Apart from these, larger lights were not provided till the Free Port was established. Following the construction of breakwaters, lights were provided on the pier heads, and leading lights were put up to mark the entrances. Also various channels in the South Harbour were marked with leading lights.

The oldest harbour lights burned kerosene or acetylene-gas. About 1925 most lights were electrified as this system demanded considerably less maintenance. However, electricity also may fail, and new smaller lights are therefore Aga-lights, burning gas. Some of them are burning continuously, while others are controlled by so-called sun-valves.

In addition to lights, and the buoys and beacons known from olden times, the Port Authority in 1923 put up an electric foghorn at the "Kronlobet" and another in 1953 at the "Provesten Harbour." In 1940 the "Kronlobet" was also provided with a radio direction finder, which in 1954 was replaced by a modern radio beacon.

During later years there has been some discussion whether the Port ought to install harbour radar for guiding ships, but so far the costs have not been considered justified on account of the excellent access to the harbour and the very limited number of days with fog.

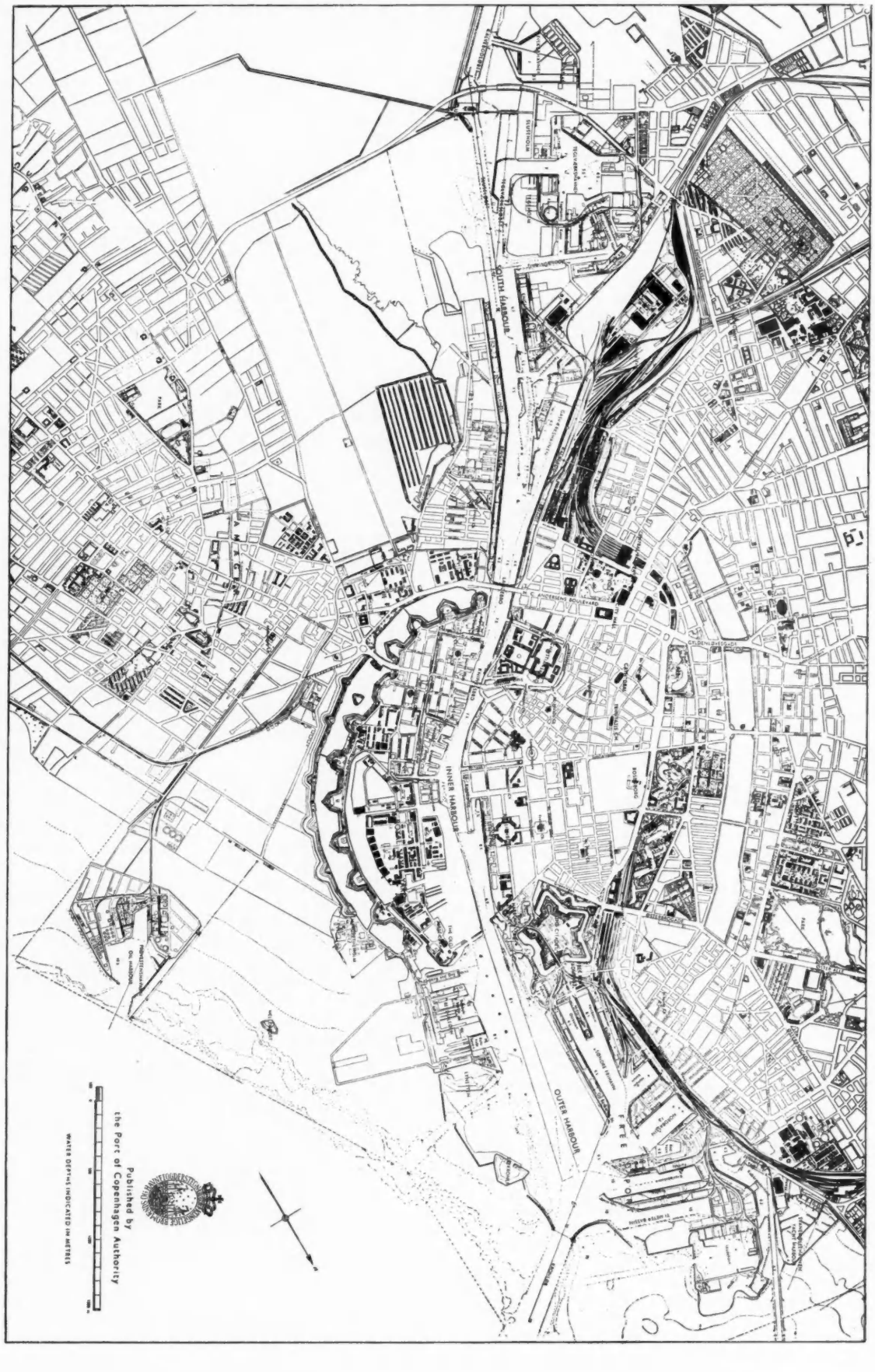
Floating Equipment

In former times dredging was one of the most important technical services in the harbours. A constant battle was fought against mud and sand, which partly came from the city sewers and partly from ships' ballast. In the Port of Copenhagen the dredging service was carried out by the navy, both in the commersion port and in the naval harbour. This service continued until 1865, although the expenses in connection with dredging in the commercial harbour were defrayed by the Port Authority. From the above date the dredging was taken over by the Port. The Navy did not possess dredging equipment, but left the work to contractors. As the Port now wanted to take the matter in its own hands the necessary equipment had to be procured, and it was natural to take over the material belonging to the "Partnership for Harbour Construction," which had hitherto been the dredging contractor. This equipment consisted of six steam dredgers, one horse-dredger, 37 barges, three steam tugs, one floating steam crane, two barges carrying cranes, and various other units. Most of the dredgers were of wood and rather old. The steam boats and the other equipment were probably also rather obsolete and with the exception of the tug "Portunus" all were soon scrapped.

For many years the Port Authority owned a considerable number of dredgers, but gradually most of these rather small units

The Port of Copenhagen—continued

PLAN of the PORT of COPENHAGEN



The Port of Copenhagen—continued

were scrapped. To replace them the present Dredger No. 1 was built in 1908 at Werf Gusto in Holland, and since 1916 this is the only real dredger of the Port.—It still serves its purpose, though no longer quite up-to-date. Besides bucket dredgers, the Port has had two floating cranes with grabs, of which only one, built in 1935 in Nakskov, is still in existence; it has diesel-electric machinery and is very useful for dredging in corners and along the quays.

In periods with large dredging projects the Port's own equipment has been quite insufficient, and in such cases various contractors have been employed.

Formerly the dredged material was used for reclamations, but in the later years the main part is being unloaded at various places in the Sound

The Port Authority has constantly had two or three tugs in service for the floating equipment. Some of these boats have also been combined fire-boats and icebreakers and could be used for excursions with visitors. Only the larger boats will be mentioned here. The steamboat "Archimedes," built in 1868 at Burmeister & Wain, was of 8 h.p. The first "Grane" of 300 i.h.p. was launched in 1891, and the "Asa" of 90 i.h.p., which is still in service, was built in 1900. In 1901 a new "Portunus" of 37 i.h.p. was procured, and in 1951 the present "Grane" was built, having an engine of 900 i.h.p. At present a new smaller boat to replace the "Asa" is being designed.

Since 1850 the Port Authority has also had a considerable number of barges and rafts for harbour maintenance.

Furthermore the Port owns patrol-boats, fire-boats, and ice-breakers. The Harbour Police have constantly had one or two steam or motor patrol boats with fire extinguishing apparatus. As mentioned above the tugs pertaining to the engineering department are also fire-boats and ice-breakers, but these boats alone are not sufficient for the icebreaking. As early as 1896 the Port Authority therefore built the large icebreaker "Sleipner" of 2,400 i.h.p. However, it was sold to Russia in 1914, as it was considered too large. To replace it the present icebreaker "Væderen" of 1,600 i.h.p. was constructed in 1916. In 1955 it was converted to oil-heating, and it is still in good condition. A more powerful icebreaker would nevertheless be desirable in a not too distant future on account of the size of modern ships.

In addition to the Port's own equipment various private equipment is employed. Towage is carried out by special companies, which have gradually increased and modernised their fleet to meet the demands of shipping. Floating cargo handling equipment has not been much used here, as the limited lightering makes this type of equipment unprofitable. Fresh water and oil for ships are delivered by various small vessels.

The Port Authority's Own Activity.

Besides the dredging, the Port has constantly employed labour for harbour maintenance, and the staff has also participated in new constructions. Even the former Royal Harbour Administration possessed pile-drivers and a diving-bell. The size of the maintenance staff has of course been varying greatly. The oldest figure I have found is from 1873 when 150 labourers were employed, in 1883 the number was about 300, in 1908 about 140, and in 1933 about 180. At present the summer staff seldom exceeds 150 men. In the last century contractors were not so widely used, and the public institutions themselves organised much of their work. Thus, the Port Authority's staff have built quay walls, breakwaters of large concrete blocks in bond, and the rather complicated piers for the bridges "Langebro" in 1903 and "Knippelsbro" in 1909. Nowadays the work is limited to maintenance and smaller new-constructions. In 1940 the workshops were moved from the southern end of the "Revshale Island" to the northern end, at the "Lynette Basin." New modern workmen's accommodation and workshops were built. There are shops for carpenters, blacksmiths, mechanics, riggers, and painters.

A hundred years ago the Port technicians were mainly occupied with harbour-and bridge-construction, but the great reclamations gradually extended the sphere of interest of the Port Authority far behind the quays, and as the general policy of the Port is not to sell, but only to lease areas, many new tasks arose, such as construction and maintenance of streets, sewers, supply-lines, and various establishments common for a number of the lease-holders. Our sewers have presented some rather difficult problems on account of the low level of the areas, and pumping plants have been necessary at many places.

At the "Provestens Harbour" the Port Authority takes care of the shunting, has established and maintains a very efficient and complicated fire protection system, and has been the intermediary in erecting a steam- and heating-plant, common to the oil companies.

Furthermore the technicians have to supervise the construction activity of the lease-holders in the Port. In this connection we are not acting as a public authority, but are merely taking care of our interests as owners, as the harbour areas in most respects come under the supervision of the various public building-, fire-, and health-authorities.

A field in which the Port has only recently been involved, is the welfare work for dock labourers. Formerly the demands for changing-rooms and washing-installations were modest, and instead of canteens private pubs were used. The new "Law for the Protection of Workers" from 1954 may impose on the Port obligations to provide buildings for such purposes, and it can be expected that certain new buildings will be necessary, probably supplemented with mobile accommodations of various kinds.

As will be noticed from the above the engineers of the Port have been busy with a lot of different problems in the course of the years. A port is a very complicated affair, and the demands which it has to satisfy are ever changing in accordance with the development of the ships, the various kinds of cargo to be handled, the prevailing means of land transportation, and the wishes of the receivers. The fluctuation in the prices of materials and the proportion between wages and prices of materials are also important, and the technical development is progressive in most fields. In olden times the Port's own technicians took care of almost everything. Nowadays specialists from outside are necessary in many cases in order to obtain the best possible results, but the Port Authority still has to co-ordinate everything in the most economical way. We hope that the future development of our Port will continue to keep our engineering department busy.

Obituary

Mr. M. G. J. McHaffie

It is with regret that we record the death on November 16th last at the age of 76 of Mr. M. G. J. McHaffie, who served as docks engineer at the Port of Southampton from 1936 until his retirement in 1948.

Mr. McHaffie joined the dock engineer's department in 1896, when the docks were owned by the London and South Western Railway Company. During the construction of the New Docks at Southampton between 1927 and 1934, he was resident engineer in charge of design and construction and, while docks engineer, he served on Southampton Harbour Board and was chairman of the works and harbours committee during the last war.

He was a member of the Institution of Civil Engineers and had served on their Council, a member of the Association of Consulting Engineers, a member of the Institute of Transport and of the Smeatonian Society of Civil Engineers and of the Engineers' Guild. He held the rank of Colonel in the Engineer and Railway Staff Corps, and he was a former president of the British section of the Société des Ingenieurs Civils de France. Shortly before his retirement he served on a commission appointed to report on the facilities and possible development of harbour and port works at Beira, Portuguese East Africa. For his work in furthering relations between British and French engineers, Mr. McHaffie was awarded the Croix de Chevalier du Merite Maritime in July, 1953.

Future Trends in Dock and Harbour Engineering

Review of Possible Developments During the next 25 Years

By J. A. WILLIAMS, M.I.C.E., M.I.Struct.E.*

Fundamental Problems

In common with other branches of industry the primary objective of maritime structural engineering is to provide economical facilities for the users, in this case port authorities, wharfingers and industrialists. The problems which arise fall readily into two categories, each of which can be associated with either "Docks" or "Harbours." In practice the two often overlap, but this need not affect the present discussion.

In dock work the governing factors are man-made considerations such as the expected size of ships, the loads and clearances required for cargo handling equipment and probably, in the near future, the disposal of wastes from atomic powered vessels. The problems are synonymous with the development trends of the industry and cannot be divorced therefrom; for so long as it is economical to build ever larger tankers, or to begin handling, say, salt in bulk, then for so long will engineers be called upon to devise the means of achieving these desired results. The opportunities afforded thereby for the exercise of skill and ingenuity are virtually limitless.

A different set of conditions governs the construction of harbours, engineers now confronting all the furies of nature. To watch the sea, backed by half a gale, hurling itself destructively against a massive breakwater is to appreciate the enormous and often unpredictable forces unleased against harbour structures. So in harbour engineering the problems of the future will remain those of wind and water. The scope for constructive thinking should not be in any way restricted by this. Rather, there should be an impetus towards the evolution of new methods of combating the old foes as experience and data are accumulated over the years.

Importance of the Subject

It is essential to establish the basic necessity for any enterprise before considering the details, otherwise the means may ultimately appear to justify the end. Thus the question of whether or not major port construction will be necessary during the next twenty-five years must be investigated. If the need is established, then the possible trends of development can be considered.

The following published figures illustrate the development of world fleets between 1939 and 1957 (the date of writing):—

Description	1939	1957	% Increase		
World's Merchant Fleet (excl. trawlers, tugs, etc.)	60	100	86	67	43
World's Merchant Fleet dry cargo vessels ... (excl. trawlers, tugs, etc.)	49	70	56	43	14
World's Oil Tanker Fleet	11	—	30	—	180

Figures show 1,000,000's gross tons.

Note: Oil tankers are normally quoted as deadweight tons; for the above approximate table, gross tons have been taken as $\frac{2}{3}$ x ddwt. tons.

The foregoing figures considered in conjunction with present-day world requirements of all commodities suggest that continued expansion over the next twenty-five years is extremely probable although the emphasis may be increasingly on bulk carriers.

In addition to these general trends there will inevitably be intensified development of Africa and possibly South America during the next quarter century which will necessitate commensurate harbour construction schemes.

Therefore, whilst it would be rash to assume that "shipping" as we know it to-day will persist throughout all future ages of man, there appears to be sufficient evidence to demonstrate that maritime structural engineering will continue to be of outstanding importance in world affairs for at least twenty-five years to come.

History

Again, before attempting to evaluate future trends it may be profitable to survey briefly the past and the present position.

Harbours have been prized throughout all recorded history, it being axiomatic that nations—indeed civilisations—have prospered or perished according to their ability to construct harbours. Yet until the Industrial Revolution few remarkable developments, apart possibly from size, had occurred. Masonry and timber were the standard constructional materials, whilst designs were based on hard experience and previous practice.

From the Industrial Revolution to the 1930's, changes in building techniques occurred as power-driven plant was developed. Iron became an orthodox structural material followed by steel and concrete used separately and in conjunction. Concurrently, methods of structural analysis were developed which rationalised at least some aspects of design. The characteristic throughout, however, was gradual development. Whilst naval architects gradually adopted steel in place of iron and timber, structural engineers slowly began to use reinforced concrete instead of timber. Wars and emergencies engendered sudden spurts of progress, but the gains were often lost by intervening slumps. True, after 1914 the whole tempo of life was perceptibly accelerated, but even as late as 1930 the engineering future generally seemed set in certain defined channels. Perhaps no branch of engineering appeared more settled than maritime structural engineering, as typified by its mass concrete dry docks, reinforced concrete quays and steel framed dockside sheds. Then suddenly, between 1939 and 1944, maritime structural engineers were presented simultaneously with, on the one hand, soil mechanics, prestressed concrete, light alloys and the plastic theory and on the other hand the prospect of 100,000 ton oil tankers, atomic power and an inflationary economy often accompanied by stifling legislation. It is against this background that the stage is set for a review of the twenty-five years ahead.

Harbour Engineering

The design of a harbour involves consideration of winds, wave forms and ocean currents to enable the most favourable approach and anchorage conditions to be evolved, and consideration of littoral drift and, often, river flow, to ensure maximum freedom from siltation. As a result the most important structural feature of a harbour is usually a breakwater. Up to the present the mass and shape of a breakwater have been critical in resisting the forces of winds and waves whilst the alignment has determined, broadly, the bed regime; both shape and alignment have affected wave-reflections and ranging within the harbour. Future harbour developments will probably show three distinct trends.

First, a great rationalisation of design methods centred upon traditional materials can be expected. Improved methods of shaping and handling these materials are constantly emerging, the concrete "Tetrapod" being one post-war example; others will undoubtedly follow. Combined with this will be the manufacture of higher quality products more resistant to abrasion and deterioration in seawater. These developments will result in more logical designing and hence in quicker and cheaper construction.

Secondly, some non-traditional ideas will be developed by engineers who forego concrete and steel in searching for an entirely new method of quelling the waves. An outstanding

* Paper read at the Fiftieth Anniversary Conference of the Institution of Structural Engineers, London, October, 1958.

Future Trends in Dock Engineering—continued

example of such development is already to be found in the pneumatic breakwater. This device was first demonstrated in 1917 but subsequently remained dormant until recent trials, principally at Dover, gave it a new impetus. The system involves only the discharge of compressed air at sea-bed level, this being found to reduce certain wave forms. No breakwater structure in the normal sense is required. It is reported that further Dover tests in 1956 resulted in a significant reduction in storm waves for an expenditure of one horse power per yard run of breakwater and that, as a result, 900-ft. of pneumatic breakwater is to be installed as a permanent harbour feature. The advantages of being able to "switch on" a breakwater according to weather conditions will be apparent. Apart from its potentialities as a permanent breakwater this device may prove to be an important adjunct to constructional plant working in the open sea, or a means of quelling local storm turbulence in lock entrances.

Thirdly, during the next quarter century there should appear an ever-increasing amount of data on winds, waves and tides which will promote more positive model studies. Also improvements in model techniques, particularly those concerned with bed materials and dredging studies, may be confidently expected. Already the use of radio-active tracers to study bed movements in coastal waters is practicable, although still subject to some administrative difficulties.

Thus in twenty-five years' time harbour design will have become, if not quite so precise as the design of a beam, at least much more of a science than the art it is to-day.

The annual freezing up of some northern ports is a separate feature of harbour engineering which is important to the affected countries. Developments which may prove of far-reaching significance in this connection are reported from Sweden. Experiments conducted by the Västeras Harbour Board indicated that compressed air discharge at bed level broke up the frozen surface of a shipping channel and enabled a passage to be forced. Figures quoted were that a 60 mile channel 50-ft. wide was maintained by a total of 6,000 cubic feet of air per minute supplied by 8 compressor stations. The capital cost was £138,000, whilst annual charges were estimated at about £21,000, including interest and depreciation.

In summary it can be said that we are probably on the threshold of several significant advances in harbour engineering which could well make the next twenty-five years one of the outstanding periods in the development of maritime structural engineering.

Dock Engineering

In order to assess the future demands on structural engineers for dock works it is necessary to examine the expected development of ships and shipping methods.

First, it has been shown that the total tonnage of world dry cargo shipping can be expected to increase. It is, however, less likely that the size of individual vessels in this trade will increase beyond the maximum already afloat. Although the average general cargo vessel had increased from about 5,000 gross tons in 1939 to some 8,000 tons in 1957, this rate of growth, even if continued, should not embarrass major ports in the foreseeable future. The general cargo vessels include both tramps and liners and one incidental change does appear to be developing at the present time. This is the emergence of purely passenger vessels such as the "Southern Cross." As an increase in passenger traffic seems improbable the day of the very large liner of the "Queen" class may be over, apart perhaps from occasional "prestige" vessels. So, even with the appearance of supertramps such as the M.V. "Sonata" (9,000 gross tons), most existing ports may well be capable of handling all general cargo vessels appearing during the next twenty-five years. As increased tonnage is often most easily obtained by increased draft, some of the smaller ports may however be faced with the expense of providing deeper berths.

Secondly, tankers and other bulk carriers, unlike general cargo ships, are increasing rapidly in all dimensions. Vessels of over 100,000 deadweight tons are practicable and with new forms of propulsion these may soon be travelling at speeds of 30 knots or more. Separate dock facilities associated with the particular product carried by these vessels are already being constructed and such developments must inevitably continue until the economic limit of the ships has been finally determined.

Thirdly, methods of handling most cargoes are being revolutionised; as an example the port of Liverpool began handling bulk sugar in 1952 and has subsequently developed this method enormously. Palletisation on a standardised international scale is well within the possibilities of the next quarter century and increasing automation will intensify such trends.

Fourthly, the widespread adoption of atomic power for ships is extremely probable. Its technical feasibility has already been demonstrated by the U.S. submarine "Nautilus" and American builders have subsequently prepared details of atomic propelled cargo liners. At the time of writing the economical size for such vessels has not emerged and, whilst the detailed development pattern is therefore uncertain, there is nothing to suggest that ship sizes will exceed those of vessels powered by other means.

The above four points indicate that most of the dock engineering problems likely to arise in the next twenty-five years could be solved by the proper application of present day methods and materials. In practice, however, the continuing need to replace capital costs will undoubtedly produce new types of structure. These, by the ingenious disposition of the members and the incorporation of new materials, will ensure the promoters' specifications being fulfilled at minimum cost. Examples of this trend already exist, such as the recent transit shed at Southampton and the many fendering devices designed for berthing large tankers.

More startling developments are possible in the realm of dockside auxiliaries. For example, the future might see the gradual disappearance of that commonplace structure, the dockside crane. Especially in new ports abroad the emphasis may well change to mobile (i.e. road wheeled) cranes, improved ships' gear, roll-on-roll-off plant, conveyor belting and even pumping. Where the traditional cranes survive they will undoubtedly take on new structural forms as in Bremen and Hamburg. Dockside sheds may also undergo revolutionary changes. These are costly structures, but the cost is largely devoted to making a self-supporting fabric. This means resisting gravity. If, conversely, pressure could be applied from the inside it would be possible to build a lighter and cheaper fabric, the principal stress in which would be direct tension. The writer has investigated this principle for covered storage of liquids with indications of savings in cost of up to 20 per cent. in favourable ground conditions. Pilot studies of a compressed-air-supported grain warehouse have been undertaken in Ohio and full-scale construction is expected to follow in due course.

Thus in dock engineering also the next twenty-five years will almost certainly bring major developments of a fundamental and far-reaching nature.

Shipbuilding and Ship Repairing

Facilities for building the largest vessels likely to be required during the next twenty-five years already exist and as this paper excludes naval architecture and shipbuilding techniques the emphasis will be on ship repairing. It is however suggested later that the two sides of the industry could benefit from some form of amalgamation in certain circumstances.

At present the outstanding problem facing many ship repairers is the provision of dry docks to accommodate the ever increasing size of tankers. The "Universe Leader," already in service, has the following dimensions: 780-ft. x 114-ft. x 46-ft. draft x 65,000 deadweight tons and larger tankers are being built. Before the war the standard tanker was 12,000 deadweight tons. These figures illustrate the magnitude of the problem. In addition to fianancing new dock construction ship repairers must be reasonably satisfied that they can keep the docks occupied by large vessels. This sometimes causes hesitation and perhaps opportunity is lost. Several possible solutions to the dilemma will now be considered.

First, novel designs for dry docks can be evolved in order to reduce costs. Since the war several docks of unorthodox design have been constructed, notably on the Tyne and at Schiedam,

Future Trends in Dock Engineering—continued

Netherlands. Some have achieved significant reductions in capital cost. As a yardstick the writer considers 10s. per cubic foot of internal dock volume to be a reliable average cost for orthodox dry dock construction under normal site conditions; this includes the body of the dock, the gate and the pumps, but excludes cranes and other ancillaries. As however most yards are already restricted for space, the designers' scope may also be thereby limited and a design offering a much reduced cost by embracing a greater area cannot be implemented. As a high proportion of the total cost is usually attributable to the heavy retaining (dock) walls, often constructed in deep trenches, the significance of the above limitation will be appreciated.

This restriction suggests a second and more fundamental solution to the problems of the ship repairing industry. This solution is no less than the dispersal of the industry throughout selected areas of the world. Within broad limits ships could be repaired anywhere adjacent to regular shipping routes. Materials are now available in many places previously without resources; in addition special materials could be distributed by large vessels when in ballast. Managers could visit the furthest "branch" and return within ten days. Strategic interests might be served by dispersal of vital industry. Finally there would be a magnificent opportunity to develop yards "de novo." All this was done on a limited scale as a war-time emergency when capital-ship docks with ancillary repair yards were built at Sydney and Cape Town. A much more extensive development is now envisaged. The difficulty of capital cost would certainly be accentuated initially, but the best solution may ultimately result from planning in the grand manner rather than by concentration on detail. Furthermore it might be to the benefit of all if the ship repairers and those with a direct interest in an efficient merchant marine could produce a joint financial policy. A fundamental revision of industrial taxation must precede any major development on the lines envisaged above.

A third possible approach to the problem is now offered. On the mainland of Europe, ships are commonly built in dry docks constructed specifically for the purpose. In Britain slipways are invariably used; the idea therefore occurs that it might be economically possible to devise a means of reversing the process and returning vessels to the slips for repair. At present the upper limit for economic repair slipways is generally taken as 1,000 tons. Also, at present, shipbuilders naturally want their slips continuously occupied by new work, but integration within the building and repairing sections of the industry might overcome this difficulty. There remains the major task of getting a large ship (much heavier than when launched) back up the slipway. Here the dawning age of unlimited cheap power might provide a convenient solution. To compromise, it would appear profitable to examine new ways of raising ships above high water. The simple floating dock is a partial answer, but some improved means of using the tide, or of using pumped air or water as a "lift" may yet prove to be the outstanding development of the next twenty-five years in the ship repairing world.

Strategical Considerations

Brief reference will be made to one aspect of strategy in relation to its possible demands upon maritime structural engineering resources. Now that guided missiles can range the globe, dispersal of potential targets no longer provides full immunity. It does spread the target area and so could be of some value. The necessary complementary development may be the construction of underground ports with underwater approaches. The conception of such installations, buried in the coastal hills, receiving vital supplies from fleets of atomic-propelled submarines may appear to be a plunge into the deeper waters of science fiction. Nevertheless, at the time of writing it is reported that the first dry cargo submarine is under construction in Japan. Should future strategical planning call for such underground and underwater facilities on a large scale, structural engineers would be presented with an unprecedented opportunity to display their skill and ingenuity.

Design Methods and Constructional Materials

Methods of structural analysis are being constantly developed and rationalised with the object of calculating more certainly the stress patterns in structures. Apart from pure research, such advances lead logically to the use of less material; this in turn implies thinner members which are then more vulnerable to corrosion. As new design methods will be used increasingly during the next twenty-five years great care will have to be exercised with both materials and methods of construction, otherwise the overall safety of the structures may paradoxically be reduced as a result of advances in design knowledge. To counteract this risk two trends of development appear probable.

First, great advances in the protection of orthodox materials, especially steel, can be expected. Maritime structural engineers in particular urgently require research organisations to produce a coating which will adhere to steel piles during handling and driving. An additive is already available which, it is claimed, increases adhesion and another is marketed which enables paint to be applied under water. These are important developments but are not yet the complete answer and further improvements are keenly awaited. Attention could also profitably be given to the production of additives to ensure higher quality tremied concrete. Moreover, there is scope for the development of new techniques in under water concreting which will obviate the drawbacks of the tremie itself.

Secondly, new structural materials will undoubtedly emerge during the coming quarter century. These will be offered as stable materials free from the defects of "old fashioned" concrete and steel. Already new forms of rubber fendering are regarded as "orthodox" whilst synthetic rubber with enhanced properties is now available; similarly light alloys, high tensile steel and prestressed concrete have ceased to be novelties; glue has not yet ousted the $1\frac{1}{8}$-in. bolt for maritime timberwork, but the range of glues now available does not preclude even this change in the near future; several possible uses for compressed air have already been described whilst "plastics" in general are becoming common. As an example of the latter the production of pyroceram was announced in 1957. This material is reported to be lighter than aluminium, to have a flexing strength of 20 tons per square inch, to retain its strength at 1,300°F., to be acid and alkali resistant and to be capable of being pressed or rolled. Armed with this material structural engineers might be excused for thinking that the Millenium had indeed arrived!

Conclusions

Summarising this review of possible trends in dock and harbour engineering it is suggested that the next twenty-five years will offer unrivalled opportunities for imagination and ingenuity. Both will be required to solve the problems raised by man's old adversary, the elements, and to solve such new problems as man himself will raise. As a result there should be a great increase in the knowledge of materials and structural behaviour. It will, however, still be of paramount importance to approach each problem with a completely open mind and not to become bemused by past successes. This will sometimes lead to unorthodox designs and courage may begin to ebb. In such event it will be wise to recall that the original Seven Wonders of the World were no doubt dismissed as impossible immediately prior to construction. So in the future as in the past, the solution of each new problem should be governed only by sound engineering principles allied with the latest available knowledge. On this basis new ideas will produce structures worthy of this age of opportunity and which will surpass even the greatest glories of the past.

Finally it may be appropriate to end with the realisation that the experience and knowledge accumulated over the next quarter century in the structural engineering aspects of inter-ocean transport may well form a basis for the first planning of the ports and harbours of inter-space transport.

Acknowledgments

The writer wishes to thank Mr. D. V. Buck, M.I.Struct.E., M.I.C.E., and Professor W. Fisher Cassie, Ph.D., M.S., F.R.S.E., M.I.Struct.E., M.I.C.E., for reading the draft paper and offering constructive criticisms.

Waves in the Irish Sea

By MOLLIE DARBYSHIRE, B.Sc.
(National Institute of Oceanography, Wormley)

Introduction

Waves have been recorded since November, 1956 by a lightship in Morecambe Bay, in the position 53°55′N., 3°29′W., where the depth is 12 fathoms, using a ship-borne wave recorder (Tucker, 1953, 56). This is the first time that a systematic series of instrumental wave measurements has been made at sea in the neighbourhood of the British Isles. These observations enable a study to be made of wave generation in conditions where the depth is comparable with the wavelength. The wave recorder operates at a depth of 6-ft. below the water-line and records were taken for eleven minutes every hour from 9.0 a.m. to 6.0 p.m. The maximum wave height recorded and the significant wave period (i.e. the mean period of the highest third of the waves), were found for each record taken from November 13th, 1956 to November 12th, 1957, except for the period March 20th to April 16th. The height has to be corrected to allow for the differing response of the instrument to waves of different period by substituting the value of the significant period in the response formula given by:
(wave amplitude)/(recorded amplitude)

$$=0.83\ [1+(8.8\mu)^{-2}]^{3/2} \exp(\mu^2 d/g)$$

where $\mu = 2\pi/\text{Period}$, d the mean depth below the water-line and g acceleration of gravity.

Statistical Distribution of Wave Heights and Periods

Fig. 1 gives the statistical distribution of wave height in the form of the log-normal curve previously used by J. Darbyshire (1956), for waves in the Atlantic and other areas. A curve is shown for the observations of the whole year and also for each month separately.

The curves are given by the equations:

Whole year	$y=20 \exp-(\log x-\log 0.5)^2/5$
January December	$y=22 \exp-(\log x-\log 2.5)^2/1$
February September October November	$y=22 \exp-(\log x-\log 1.5)^2/2$
March August	$y=22 \exp-(\log x-\log 1.5)^2/1$
April July	$y=30 \exp-(\log x-\log 0.5)^2/3$
May June	$y=50 \exp-(\log x-\log 0.5)^2/2$

where y is the percentage probability of a wave having a height between x and x+1-ft. The highest wave recorded was 28-ft. on November 1st, 1957, with a significant period of 7 secs.

Fig. 2 shows similar frequency distributions for the significant wave period. The log-normal distribution appears to hold here also. The curves are given by the equations:

Whole year	$y=34 \exp-(\log x-\log\ 5)^2/0.1$
January December	$y=30 \exp-(\log x-\log\ 6)^2/0.1$
February March September October November	$y=40 \exp-(\log x-\log\ 5)^2/0.1$
April May June July August	$y=40 \exp-(\log x-\log 4.5)^2/0.1$

where y is the percentage probability of a wave having a period between $x-\frac{1}{2}$ and $x+\frac{1}{2}$ secs.

Effect of Varying Wind Direction

Although Figs. 1 and 2 are very informative and show up seasonal fluctuations, they do not give an adequate representation of the effect of the varying wind conditions met with in the Irish Sea. Fig. 3 is a map of the Irish Sea, showing the position of the lightship. Lines are drawn radiating from the ship's position at at angles of 20° and if one thinks of the wind blowing along these lines at different times, there is clearly a large variation of fetch with wind direction. The wave records taken by the ship were accordingly split up into 18 classes a, b, c, d . . . . p, q, r corresponding to wind directions 0—20°, 20—40° . . . . . 340—360°. The wind speed and direction were obtained from the values

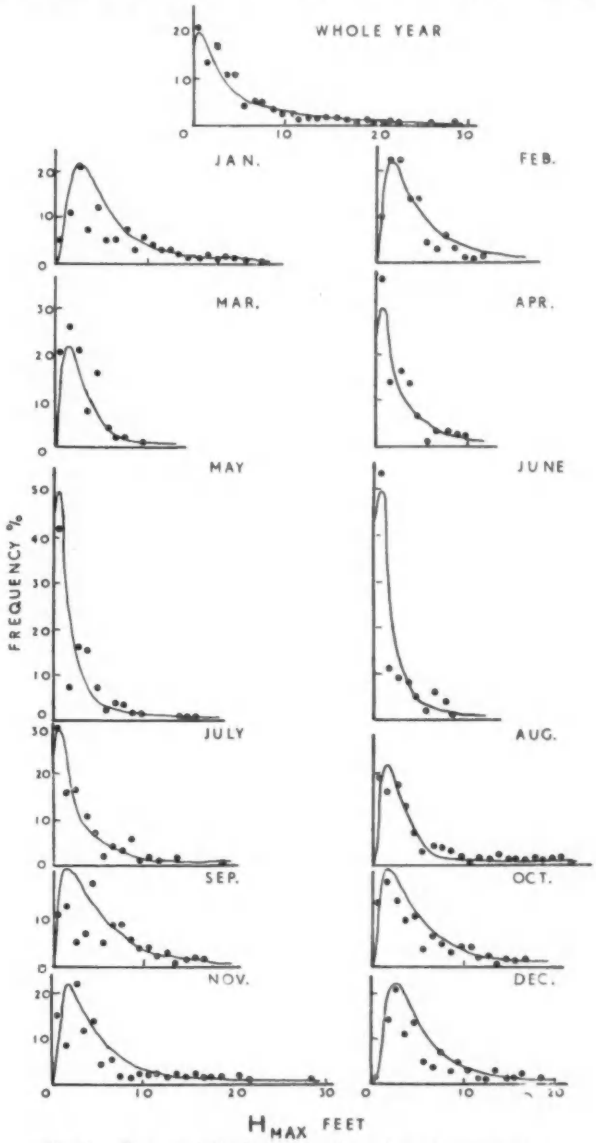


Fig. 1. The statistical distribution of maximum wave height for the whole year and each month separately.

shown in the Air Ministry Daily Weather Charts for stations Valley, Ronaldsway and Squires Gate (positions shown in Fig. 3). The mean of the values of wind speed and direction given by all these stations over the past three hours were found by interpolating from the values given six hours previously. The value found for the direction determines the class of the wave record.

Values of maximum wave height, H_{max}, were plotted against the wind speed for each class. The variation was found to be of the form

$$H_{max} = AW^2$$

H_{max} in feet
W surface wind speed in knots.

Waves in the Irish Sea—continued

Values of A were obtained by the method of least squares and are given in Table I, which also gives the number of observations of H_{max}, the maximum wind speed, and the fetch for each value. The values of A are plotted on a polar diagram in Fig. 4.

Similarly values of significant wave period were plotted against the wind speed for each class and the variation was of the form

$$T_{1/3}=BW^{\frac{1}{2}} \qquad T_{1/3} \text{ in seconds.}$$

Values of B were also obtained by the method of least squares and are also shown in Table I. The standard errors of the variations of H_{max} with W^2 and $T_{1/3}$ with $W^{\frac{1}{2}}$ are given for each class.

The original plots of H_{max} against W, and $T_{1/3}$ against W, showed a good deal of scatter which is indicated by the standard error values. This shows, since the values of fetch and wind

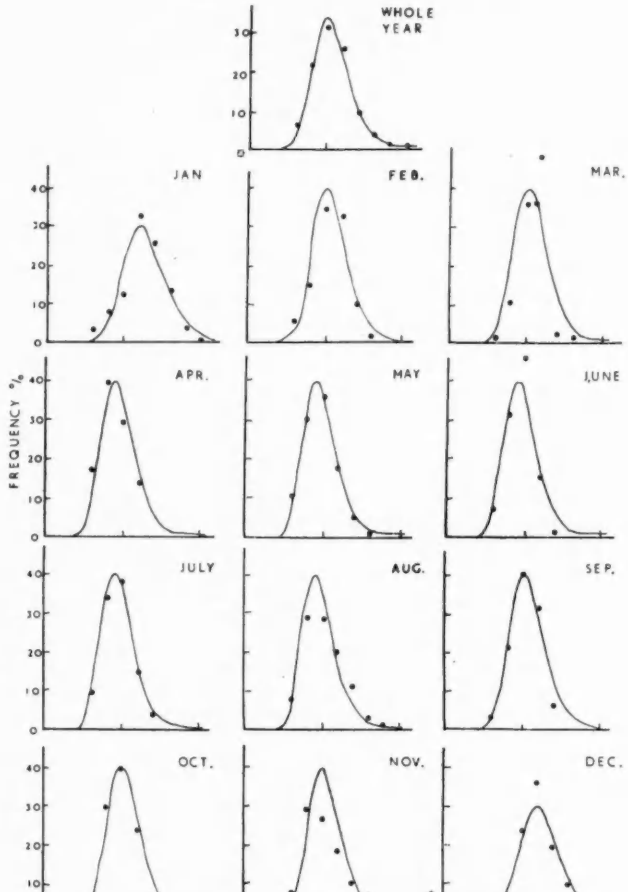


Fig. 2. The statistical distribution of significant wave period for the whole year and each month separately.

speed must be reasonably accurate, that there are several other factors affecting wave generation in a shallow sea like this. The turbulent effect of tidal streams, for instance, is very difficult to assess precisely. It may be this effect which causes waves in classes n, o, p, q, r to be higher for a given wind speed than waves in classes l and m although the fetch is greater in these last two cases.

The values of A for the larger fetches are of the same order as those obtained by J. Darbyshire (1955) for Atlantic conditions. If W, the surface wind speed is taken to be 2/3 the gradient wind speed U, then the Atlantic formula becomes

$$H_{max}=0.0171\ W^2$$

which is of the same order as that found for classes k, l, and m. These correspond to south-westerly winds with the fetch extending to the Atlantic and so tend to approximate more to deep sea

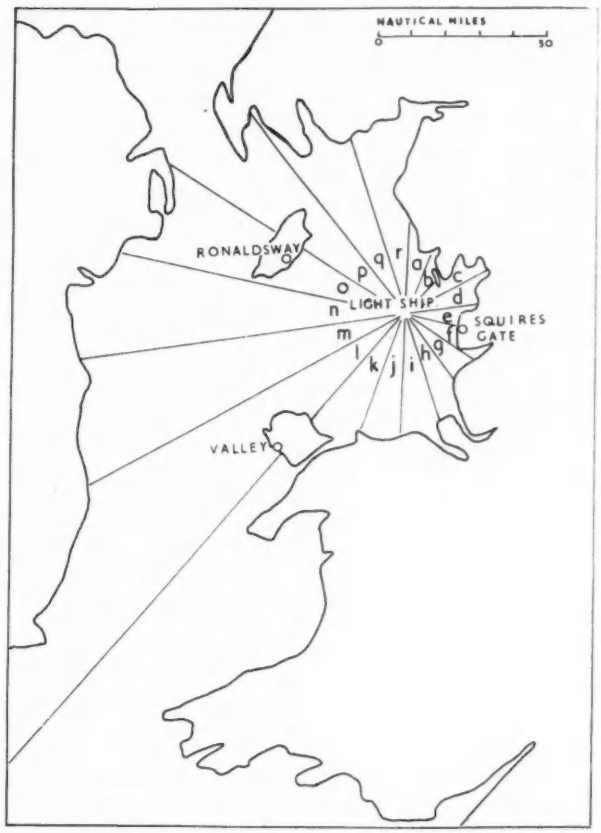


Fig. 3. Map of the Irish Sea showing the position of the lightship and the wind direction classes used.

conditions. The values of A for classes n, o, p, q, r, are, however, greater than would be expected for the open ocean.

The equation for wave period given by J. Darbyshire (1955), is

$$T_{1/3}=2.00\ W^{\frac{1}{2}}$$

which gives significantly greater periods for a given wind speed than any equation found for the Irish Sea. One must assume that because of the relatively shallow depth, longer waves cannot develop to their fullest extent. Figs. 5 and 6 show respectively the variation of A and B with fetch. It will be observed that for

Table I

Variation with wind direction

Class	No. of obs.	A	s.e of H_{max}, ft.	B	s.e of $T_{1/3}$, secs.	Fetch n.miles	Max wind speed knots
a	122	0.0174	±1.2	1.36	±1.2	18	17
b	129	0.0152	±1.2	1.17	±1.1	15	18
c	118	0.0096	±1.3	1.08	±1.4	22	21
d	156	0.0079	±1.1	1.00	±1.1	21	23
e	131	0.0109	±1.1	1.05	±1.5	16	24
f	102	0.0124	±1.3	1.32	±1.4	17	29
g	140	0.0110	±1.2	1.31	±1.3	23	29
h	184	0.0098	±1.3	1.28	±1.2	34	27
i	174	0.0097	±1.5	1.29	±1.3	36	32
j	184	0.0146	±1.6	1.44	±1.2	37	31
k	293	0.0174	±2.2	1.46	±1.1	65	30
l	339	0.0179	±1.9	1.39	±1.0	130	32
m	330	0.0189	±2.1	1.44	±1.1	102	34
n	297	0.0210	±1.9	1.43	±1.0	99	32
o	182	0.0230	±1.8	1.45	±1.0	79	32
p	184	0.0226	±1.9	1.40	±0.9	116	27
q	173	0.0220	±1.6	1.39	±0.9	60	26
r	94	0.0215	±1.7	1.39	±1.1	56	17

Waves in the Irish Sea—continued

B, the values seem to flatten out after 20 miles, or so, indicating a saturation state. For A the same state of affairs occurs after 40-50 miles. There is some evidence, however, which will be discussed more fully in another paper, that with light winds, the saturation distances get longer which suggests that the shorter, lower waves, then produced, can develop more fully.

The Effect of Atmospheric Stability

The foregoing discussion has not taken into acount variations in atmospheric stability due to the difference between the sea and air temperature. When the sea temperature is greater than the air temperature, conditions become unstable and there is some evidence (Fleagle, 1956), that waves should be higher for a given wind speed under such conditions. This effect was investigated in the Irish Sea by further dividing each class into three sub-classes:

(1) With the air temperature more than 1°C. higher than the sea temperature, corresponding to stable conditions.

(2) The difference between the air and sea temperature being 1°C. or less, corresponding to neutral conditions.

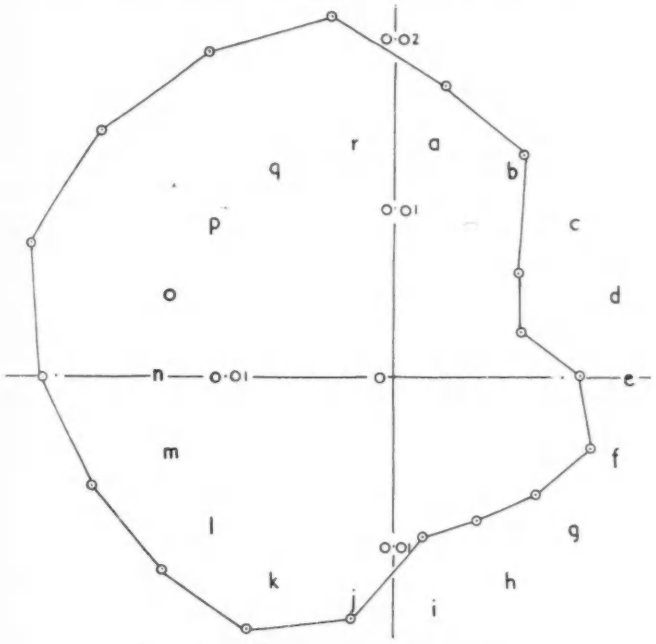


Fig. 4. Plot of A against wind direction.

(3) The sea temperature being more than 1°C. higher than the air temperature, corresponding to unstable conditions.

The constants obtained for these classes will be denoted by the subscripts s, n, and u. The air temperatures were obtained from the Daily Weather Chart values given by the three meteorological stations, already referred to while the sea temperatures were kindly provided by the Oceanographical Department of the University of Liverpool. Values of A_s, A_n, and A_u were found for each class and they are given with the standard errors of the variation of H_{max} in Table II. The polar diagram in Fig. 7 shows the value of A_u/A_s and A_n/A_s, the circle representing unity. A_u is significantly greater than A_s for the classes r to h, where the fetch is small, and the waves not fully developed. Where the fetch is longer as in classes i to q, however, the effect is not so, A_s and A_u being appreciably the same over this range, A_s being greater than A_u in two cases. The ratio of A_n/A_s follows much the same trend although there are some differences in individual cases. One would draw the conclusion then that for the Irish Sea, at any rate, the effect of increased wave height due to atmospheric instability is only significant for under-developed waves.

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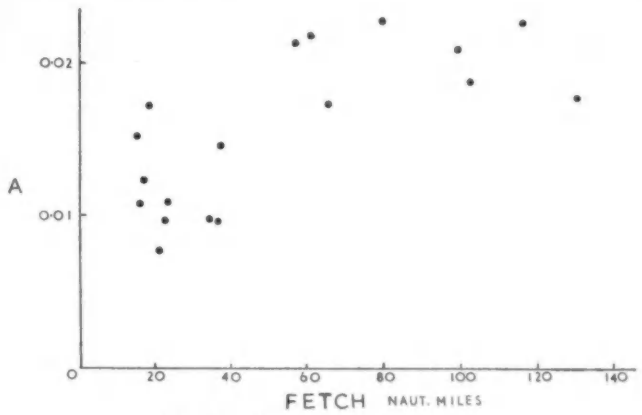

Fig. 5. Plot of A against fetch.

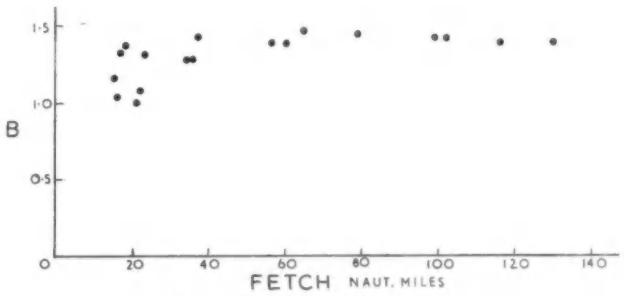

Fig. 6. Plot of B against fetch.

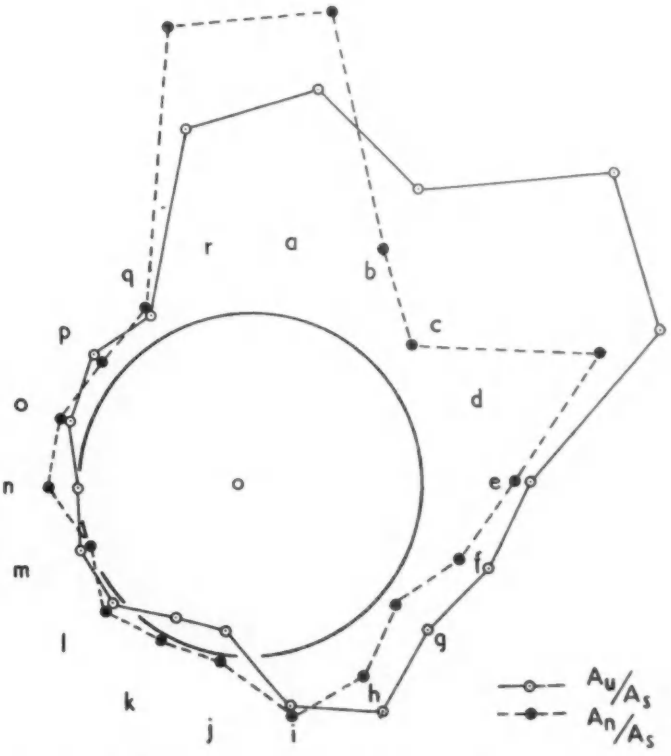

Fig. 7. Plot of A_u / A_s and A_n / A_s against wind direction, the circle representing unity.

Trends in Channel Improvement and Vessel Construction

Greater Depths Needed for Modern Ships

AT the Inter-American Port and Harbour Conference held in San José, Costa Rica, in the spring of 1956, a study of Trends in Channel Improvement and Vessel Construction, prepared by the American Merchant Marine Institute, was presented by the United States Delegation. This document was considered to be of substantial technical value and its publication having been brought up to date was approved by the Permanent Technical Committee on Ports (an organisation attached to the Inter-American Economic and Social Council of the Organisation of American States) at its first meeting in March, 1958.

The constant inter-action between ships' dimensions and channel capacities has reached a critical stage in the post-war years mainly due to the superior economy of transporting oil and ore in larger vessels than were hitherto contemplated for these trades, and port authorities in Europe, as in America, are faced with the problem of deciding to what extent it is advisable or indeed possible to increase the depths and widths of their approach channels and berths to cater for the present and ever growing fleet of giant tankers and ore-carriers.

They have been assisted in their task by the work of the Permanent International Association of Navigation Congresses (the U.S., British and Western German national committees have published studies on the subject) and the following extremely well documented study will undoubtedly provide further valuable guidance. The position in Europe is not necessarily the same as that in the Americas and the British National Committee of P.I.A.N.C. have sounded a note of restraint in recording that not every port will require to provide facilities for the largest vessels operating in the world. However, bearing in mind the enormous capital costs involved in bringing about even comparatively minor increases in channel depths, and the recurring costs and technical difficulties of maintaining them, any competent study of the relevant facts is of value and one of the quality and authority of the recent American study is a worthwhile addition to the documentation on the subject. It is printed hereunder in full.

Since the early beginning of our Government, the navigable waters of the United States have been under the charge of the Corps of Engineers. The American Merchant Marine Institute, Inc. wishes to state at the outset that in its judgment, the Corps of Engineers, over the course of more than a century have done an outstanding job both in the development and in the maintenance of our waterways for navigation. Much credit is due to this organisation for the noteworthy advances that have been made in developing our rivers and harbours to meet the demands of a growing commerce, as a result of which they have played an important part in the economic growth of our nation.

The existing project dimensions in main channels in the United States seaports have been developed over the years under Congressional authorisation in accordance with the needs of navigation as recommended by the Chief of Engineers, U.S. Army. The basic requirement for a favourable recommendation is that the annual benefits reasonably to be expected from an improvement, evaluated on a monetary basis, must be at least equal to the estimated cost of the work including interest on and amortization of the investment, plus the increase in maintenance and operation costs. The principal sources of monetary benefits are: (a) savings in cost of transporation service, (b) the provision of service at a cost which will attract new traffic and (c) the reduction in damage to ships and structures related to navigation.

Historically, an increase in capacity and draft of vessels has preceded a related artificial increase in depths of seaports. This has resulted in disadvantages to shipping arising from: (a) sailings with less than capacity cargoes, (b) partial lightening of full cargoes to reduce draft, (c) losses of time waiting for high tide and (d) damages to vessels because of inadequate clearances. The estimated savings by elimination or reduction of these disadvantages by channel improvements have been considered to be benefits to be credited to the improvements.

Waterway Characteristics

The channel depths authorised in United States ports have been based in general on actual drafts of vessels using the channel plus the following additional depths:

(a) Sufficient water under the keel for safe and efficient operation when operating under its own propulsion—usually 2-ft.

(b) Squat or sinkage of a vessel when moving through the water in general an increase of from 2 to 3-ft.

Waves in the Irish Sea

(*Continued from previous page*)

Table II Effect of atmospheric stability

Class	A_s	s.e. feet	A_n	s.e. feet	A_u	s.e. feet
a	0.0091	±0.5	0.0251	±1.2	0.0210	±1.1
b	0.0110	±1.0	0.0172	±1.2	0.0215	±1.1
c	0.0079	±1.1	0.0096	±1.1	0.0217	±1.2
d	0.0046	±0.9	0.0099	±1.0	0.0116	±1.4
e	0.0079	±1.0	0.0120	±1.1	0.0127	±1.3
f	0.0095	±1.5	0.0121	±0.7	0.0138	±1.4
g	0.0093	±1.2	0.0101	±1.0	0.0123	±1.1
h	0.0086	±1.4	0.0110	±1.0	0.0131	±1.2
i	0.0089	±1.6	0.0118	±1.4	0.0116	±0.9
j	0.0148	±1.5	0.0152	±2.0	0.0126	±1.2
k	0.0174	±2.6	0.0180	±1.8	0.0151	±1.2
l	0.0173	±1.9	0.0188	±1.9	0.0185	±1.3
m	0.0188	±2.1	0.0189	±2.0	0.0190	±2.6
n	0.0200	±1.4	0.0234	±1.9	0.0201	±2.2
o	0.0203	±1.4	0.0234	±1.5	0.0230	±2.0
p	0.0204	±1.7	0.0232	±1.6	0.0236	±1.8
q	0.0191	±1.1	0.0230	±1.4	0.0220	±2.0
r	0.0104	±0.9	0.0279	±1.0	0.0217	±2.1

Conclusions

In general, the results for the Irish Sea show that for a shallow sea with a large tidal range, there are some significant differences in the conditions of wave generation from those which hold in the open ocean. One such difference is the relative shortness of waves generated by a wind of given strength and another is the much shorter fetch required to attain saturation conditions. The results also show that the effect of atmospheric instability is only marked for unsaturated conditions.

Acknowledgments

The author wishes to thank the Corporation of Trinity House, and the crew of the lightship for the wave records obtained, the Oceanographical Department of the University of Liverpool for the sea temperature data and the Director and staff of N.I.O. for advice and assistance in obtaining the records and preparing the paper.

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Trends in Channel Improvements—continued

(c) Trim where vessels are not loaded to even keel—usually 1 to 2-ft.

(d) Loss in buoyancy in moving from salt water to fresh water because of reduced salinity and specific gravity of the inland water—depending upon actual conditions.

(e) Tidal phenomena where water stages occur below the datum.

(f) Character of the material in the channel bottom, i.e. soft material or hard material.

(g) Wave action causing pitching of the vessel in an entrance channel.

Ships require sufficient channel width, or manœuvring lane, to allow for deviations from course due to wind, currents, position with respect to range markers, and other factors adverse to navigation. The influence of these factors has been evaluated in recent channel studies by the Panama Canal* from a poll of the opinion of a large number of pilots and navigators of the Panama, Suez, Cap Cod and Houston Ship Canals. In addition, several studies of the width of ship's path were made from observed transits of typical ships through the Panama Canal.

Certain ships because of greater power, steering aids, and streamlining of hull are capable of better control than others. The controllability of various ship types were classified as follows:

(1) " Very Good " including naval fighting ships and freighters of the Victory ship class.

(2) " Good " including naval transports and tenders, T-2 tankers, new ore ships and freighters of the Liberty ship class.

(3) " Poor " including old ore ships and damaged vessels.

Based on pilot's opinion and observation of ship courses, the required width of manœuvring lane was established as ranging from 60 percent to 100 percent in excess of the ship's beam depending upon the controllability characteristics of the ships. When navigating a course at one side of the canal axis approximately on the quarter point of the channel width, a " Very Good " ship would require a manœuvring lane equal to 160 percent of its beam; a " Good " ship, 180 percent and a " Poor " ship, 200 percent. A manœuvring lane equal to 140 percent of the ship's beam was considered adequate for ships on the centre line of canal where " bank suction " forces have minimum effect and navigation is facilitated by alignment with range markers.

For the passing condition in the Sabine-Neches Waterway, for example, the manœuvring lane of the tanker in ballast, should be 180 percent of the beam, or 162-ft. for a ship of 90-ft. beam. The manœuvring lane of the loaded tanker, because of its position nearer the centre line of channel, can be somewhat less, say 160 percent, or 144-ft. for a ship of 90-ft. beam. Also, based upon the opinions of experienced pilots and navigators, the minimum clearance between ship lanes should be 100-ft.

Bank clearance should be selected to limit bank suction forces to values which will not require a compensating rudder deflection greater than 10 degrees when ships are operating at the outer limits of the passing lane. Since the maximum possible rudder deflection of the average ship is about 35 degrees, this criteria provides a reasonable safety factor for emergency rudder application.

Application of the criteria developed in the Panama Canal studies to developed minimum safe channel sections for the T-2 type and 26,000 to 30,000-ton tankers indicates widths of 390-ft. to 480-ft. required for the condition of a loaded tanker passing an empty one, and 410-ft. to 510-ft. for a loaded tanker to pass another loaded one. The channel widths thus determined for the various tanker types are tabulated in Table I.

TABLE I

Channel Widths for Various Tanker Types

Type	Beam	Overall Length	Channel I*	Bottom Width II*
T-2 Tanker	68	523	393-ft.	410-ft.
Esso Shipping Co. ...	82.5	628	446-ft.	484-ft.
Philadelphia Tankers	85	660	480-ft.	506-ft.
1952-Tanker ...	102	735	507-ft.	536-ft.

*I —Loaded Tanker passing tanker in ballast.

*II—Loaded Tanker passing another Loaded Tanker.

Curves and Bends in Channels

The ideal alignment of a channel, but seldom obtainable because of cost, is one free from curves or bends. The difficulties in maintaining good ship control when navigating a sinuous and narrow channel in restricted and even in fairly open waters are compounded if the sight distances from the ship's bridge are limited by high hank topography or by artificial obstacles, particularly if the channel directional changes are at sharp angles.

In 1926, the following statement of curvature criteria was made in a report by F. V. de Miranda Carvalho to the XIV International Congress of Navigation:

" Admitting . . . . . a speed of 8 to 10 miles per hour for navigating and a current not exceeding the ordinary limits, it seems to us that the minimum radius may follow the rules quoted below:

"(1) When . . . . . (central angle of curve is 25 degrees or less), the minimum radius should be at least equal to three times the length of the biggest steamer passing through the canal.

"(2) When . . . . . (central angle of curve is between 25 and 35 degrees), the minimum radius should be equal to five times the length of the vessel.

"(3) When . . . . . (central angle of curve exceeds 35 degrees), the minimum radius should be equal to ten times . . . (the length of the vessel)."

Despite the favour that rules such as these sometimes receive, the needs of navigation require that changes in direction be made at flat angles wherever practicable. A canvas of a number of waterways disclosed that operators were dissatisfied with curves with radii of 4,000-ft. in which ships up to 500-ft. were operating. The desideratum is a radius of not less than 7,000-ft. for ships with lengths of 500-ft. Radii up to 10,000-ft. should be considered where the transiting vessels are up to 700-ft. in length.

Turning Basins

Turning basins are of two types:

(1) Those in which ships nose against a bank, pier, bulkhead, turning dolphin or pile cluster, either with or without the use of lines. The swinging width in such basins should be at least one-fifth larger than the length of the largest ship to be turned.

(2) Those in which ships turn by free interplay of rudder and propeller, aided by tugs if conditions require; the minimum dimension of such basin should be not less than twice the length of ship to be turned.

In general, a turning basin should have as its minimum dimension the length of the largest ship it must accept plus a reasonable allowance for safety in handling unless, as is often the case, the basin is an extension of or adjoins the channel and encroachment on the channel by a ship when turning is permitted.

Anchorage Areas

Anchorages should, where practicable, be located well away from the harbour channels, out of the path of traffic, and the location should be so chosen to ensure the maximum protection from wind and storm that the configuration of the harbour permits. Since a ship's speed when entering an anchorage is generally less than when in transit in a channel, the depth can be less than the channel depth by the difference in " squat."In general, however, anchorage depths are usually the same as for the access channels thus giving a tolerance for shoaling in the anchorage which is usually at a higher rate than in the channel.

If anchorage space is limited, fixed moorings are sometimes provided to limit vessel swing. If ship's anchors or bow moorings only are used, the area of swing for individual ships is circular in shape with radius determined by the ship's length, plus the length of anchorage chain used, plus an allowance for drag of anchor where bottom conditions are not of the best. A rule of thumb in common usage establishes the minimum length of chain as four times the depth of water in the anchorage. Where there is wind

*Report of the Governor of the Panama Canal under Public Law 280, 79th Congress, 1st Session.

Trends in Channel Improvements—continued

and strong current or swell the length of chain used is often ten times the depth.

Bridge Clearances

The usual practice in waterways where petroleum and dry-cargo are transported is for a minimum vertical clearance of 135-ft. above mean high water extending over the full width of the channel. It is usually good practice to have a clear unobstructed channel width with an adequate fendering system to provide additional safety should the vessel go out of control in passage through the bridge piers. Another method, which is to be preferred, is to locate the piers shoreward in water no more than 15-ft. deep in order that a ship out of control would be aground before striking the pier. The latter method is essential where sailing conditions are adverse.

Berths

The dimensions of a ship's berth are dependent upon the length, beam and maximum draft of vessels to be berthed and whether lightering is to be used or whether tug assistance is necessary.

The length of berth should be at least 50-ft. longer than the overall length of vessel, if the berth is for one vessel. This will allow for proper tying down of the vessel and in the case of a berth transverse to the channel at the same time will obviate any ice or debris striking against the side of the vessel. The depth should be at least 4-ft. more than the draft of the vessel below mean-low water to prevent scraping of bottom under abnormally low tides. The width of berth should be at least the overall width of the largest vessel to be berthed, plus the width of the maximum lighter or length of largest tug in use in the area, plus an allowance for tug manœuvre and for overall safety in berthing.

Trends in Vessel Construction

The majority of the authorised deepwater channel improvements in the United States are based on the requirements of the T-2 tanker with a capacity of 16,500 deadweight tons. About 480 T-2 tankers are at present using United States ports.

The T-2 tankers proved the value of the larger type vessel over that used before the war, with the result that the petroleum industry at the close of World War II made plans for vessels of even greater capacity. The advantage of the super tanker is readily apparent from the fact that they can be operated with crews not greatly exceeding those required for the T-2 tankers and at fuel costs which are lower in proportion to size. A study by the Board of Engineers for Rivers and Harbours, Corps of Engineers, of the costs of operating tankers between Texas ports and North Atlantic coast ports were, for T-2 tankers, $2.61 per ton, excluding profit, and for the 28,000-ton supertanker $1.85 per ton excluding profit.

In the past nine years, it has become increasingly evident that channels and harbours whose controlling dimensions were based on the T-2 tankers of 16,500 deadweight tons are now inadequate. Practically all tankers constructed in recent years or which are under construction have capacities ranging from 26,000 to 85,000 deadweight tons and dimensions up to 854-ft. in overall length, 125-ft. beam and drafts up to 46-ft. In the March 1957 issue of the Marine Engineering/Log, it was reported that a new contract was recently awarded for the construction of a tanker, in a United States shipyard, of 106,500 deadweight tons with dimensions of about 940-ft. in overall length, 134-ft. beam and draft of 48-ft.. The transporting capacity of these new tankers greatly exceed the carrying capacity of the T-2 tankers. The 85,500 d.w.t. Universe Leader, and its 4 sister ships, presently transporting petroleum, has the equivalent carrying capacity of nearly five T-2 tankers.

Tables II and III indicate statistically the trend toward larger oil and bulk carriers and dry cargo vessels, respectively. Table IV indicates oil tankers under contract, under construction or launched from 1947 to February 1958, inclusive, building in accordance with American Bureau of Shipping standards. A comparison of Table IV with a similar table prepared in July 1955 indicates that the number of vessels under contract, under construction or launched of 30,000 d.w.t. and over increased in percentage of total from 20 to 58 percent and that the number launched of 30,000 d.w.t. and over increased from 44 to 141.

TABLE II

Trends in Vessel Construction
Typical Oil Carriers

Date	Vessel	Overall Length ft. in.	Breadth ft. in.	Mean Summer Salt-Water Draft ft. in.	Speed Knots	Deadweight Tonnage
1906	W. S. Porter	399 2	49 9	24 0	9½	6,500
1908	Texas	413 3	52 0	24 0	12	9,232
1914	John D. Archbold	474 6	60 0	26 1	10¼	9,546
1916	Charles Pratt	516 6	68 0	27 3	10½	15,955
1918	USSB Tankers	445 0	59 7	25 6	10	10,000
1941	T-2 Tankers (T2-SE-A1)	523 6	68 0	30 2	14½	16,500
1943	Atlantic Sun	547 3	70 0	30 4½	15	17,910
1948	Esso Zurich	628 0	82 6	31 11½	16	26,555
1950	Atlantic Seaman	659 6	85 0	34 3¼	17	30,155
1953	Tina Onassis	775 8	95 0	34 9¾	16	45,000
1953	Petroking	673 0	92 0	34 7¾	15	38,000
1954	W. Alton Jones	707 0	93 0	36 6 3/16	17½	38,000
1954	World Glory	736 6	102 0	37 6¾	16½	45,110
1955	Sinclair Petrolore (Tanker and Ore Carrier)	790 0	106 0	40 0	15	55,500
1956	Cities Service Baltimore	661 0	90 0	33 11½	18½	32,650
1956	Universe Leader	854 9	125 0	46 1	14½	85,500
1957	Esso Gettysburg	715 0	93 0	36 9	18¼	37,800
1957	Tidewater	782 0	102 0	37 6	16½	53,085
1958	**Under Construction**					
	In U.S. Shipyards (for Esso)	740 0	102 0	37 10½	16	46,000
	In U.S. Shipyards (for Niarchos)	940 0	134 0	48 0	18	106,500
	Typical Bulk Ore Carriers					
1922	Marore	571 6	72 0	34 1	11	22,980
1945	Venore	582 11	78 0	34 4	16¼	24,376
1954	Ore Chief	794 0	116 0	38 8	14	60,000
1955	Leader	680 0	88 4	34 6	12¾	34,200
1956	C5-S-RM 20a	609 0	77 0	33 0	16	24,000
1957	Cosmic	744 0	100 6	37 2	16½	46,500

TABLE III

Trends in Vessel Construction
Typical General Cargo Vessels

Date	Vessel	Overall Length ft. in.	Breadth ft. in.	Mean Summer Salt-Water Draft ft. in.	Speed Knots	Deadweight Tonnage
1899	El Sud	405 9	48 0	22 0	8½	3,417
1909	Jean	382 2	46 0	20 0	8	4,600
1910	El Sol	430 0	53 0	24 0	15½	6,850
1916	Edgar F. Luckenbach	442 0	57 0	28 0	13½	10,470
1918	EFC Ships	400 0	52 0	24 0		
1934	Angelina	410 11	55 0	24 11½		7,500
1939	C-2 Ships (C2-S-AJ1)	459 1	67 0	27 7	15½	10,775
1940	C-3 Ships (C3-S-A2)	492 0	69 6	28 6	16½	12,300
	Liberty Ships (EC2-S-C1)	441 6	56 10¾	27 8	11	10,800
	Victory Ships VC2-S-AP2)	455 3	62 0	28 6	15½	10,800
1946	C-4 Ships (C4-S-B5)	520 0	71 6	32 9⅞	17	15,036
1950	Schuyler Otis Bland	475 0	66 0	28 7	18½	10,516
1952	Mariner Class Ship	563 8	76 0	29 10⅜	20	12,910
1956	Seafarer (C4-S-RM19a)	529 0	74 6	29 10	18	13,480

TABLE IV

Oil Tankers under Contract, under Construction or Launched 1947 to February 1958

D.W.T.	Total	Percentage of Total	No. Launched up to Feb., 1958
18,000 to 20,000	80	12.8	73
20,000 to 30,000	180	29.0	157
30,000 to 40,000	190	30.5	107
40,000 to 50,000	133	21.5	23
50,000 and over	38	6.2	11
	621	100.0	371

TABLE V

Size and Age of Oil Tankers
(10,000 Gross Tons and Over)
(Compiled from Lloyds Register of Shipping)

Years of Age	10,000 Gross Tons and Over	
Under 5	38 Vessels	586,438 Gr. T.
5 to 10	10 Vessels	172,743 Gr. T.
10 to 15	258 Vessels	2,721,688 Gr. T.
15 to 20	10 Vessels	111,427 Gr. T.

Trends in Channel Improvements—continued

Table V indicates the size and age of U.S. Oil tankers of 10,000 gross tons and over as of 1956. The T-2 tankers are rapidly becoming obsolete and are being replaced by the larger, more economical vessels.

It is highly probable that existing tankers, to a large extent, will be replaced by vessels of from 26,800 to 50,000 d.w.t. carrying capacity having mean loaded salt water drafts up to about 38-ft. It is imperative that the authorised navigation improvements be speeded up to complete the projects at the earliest practicable date, since by 1960 it is estimated that the proportion of supertankers (26,000 d.w.t. and over) will constitute more than 50 percent of the total tanker fleet using U.S. ports.

The opening of foreign ore sources, distant from the important world markets, since the close of World War II has brought bulk ore carriers of unprecedented size ranging up to deadweight of 60,000 tons, with drafts of 38-ft. 8-in. Three of these vessels are already launched and are trading in several U.S. ports. The actual tonnage of ores to three of the major deepwater terminals receiving imports amounts to about 22 million tons per annum and will increase at a rapid rate. The large importations into the United States or oil and ore from foreign sources is now inducing the construction of facilities for the refining, processing and manufacturing of these products on the Atlantic, Gulf and Pacific coasts which in turn will require the further enlargement and improvement of the channels with depths up to and greater than 40-ft. The trend towards larger bulk ore carriers is evident from the statistics on ore carriers as shown in Table II.

Dry-cargo vessels have similarly increased in size, speed and dimensions and it seems probable that this trend will continue. In 1951, the United States Maritime Commission commenced the construction of a fleet of new "Mariner" class of cargo vessels overall length of about 560-ft. and a capacity of 12,900 deadweight tons. This marked a significant trend in the sizes of the dry-cargo vessels which will continue, as the replacement of the Liberty and Victory type ships constructed in the period of World War II is accelerated. The carrying capacity of the new "Mariner" class exceeds the previous dry-cargo vessels by at least twenty percent.

General

The major tanker operators have over one and a half billion dollars invested in the new supertankers now afloat or under construction. The full value of these tankers to the national economy is not now being realised under the loading handicaps imposed by those channels of inadequate depth and width. It seems to us imperative that direct and immediate action should be taken by all countries in the Western Hemisphere to complete these major loading and unloading port projects within the earliest practicable time.

The benefits from the use of the large tankers in the completed deepwater ports would be far reaching since their employment at full capacity would result in corresponding savings in transportation costs. There is no type of harbour improvement from which the benefits are more promptly realised and none in which the benefits are as great as those involving the movement of crude oil and crude oil products and other bulk commodities such as ore from foreign sources.

Channel Maintenance

It is not enough that the authorised projects be carried to completion. Once the channel improvements are completed, they are committed to the use of deeper draft vessels and to the loading of the ships to the fullest extent of their capabilities. If channels are allowed to deteriorate and navigable depths are decreased by silting, great inconvenience and loss will be experienced. It is for this reason that we recommend that adequate funds be provided annually for maintenance of waterway dimensions so as to insure the efficient and economic use of the intended vessels.

Berthing Facilities for Large Tankers at Antwerp and Rotterdam

The following information on tanker berthing facilities at these two ports is based on papers by G. Schepens and H. P. Meyer respectively which were presented at the Third International Harbour Congress which was held in Antwerp in June of this year, under the auspices of the Royal Flemish Institution of Engineers.

Antwerp

The increasing size of tankers and the desirability of reducing the turn-round times calls for the provision of appropriate facilities permitting the safe berthing of the vessels in all weathers and enabling the loading or unloading operations to start immediately.

On the River Scheldt the Port of Antwerp has only an old oil jetty, a reinforced concrete structure providing a maximum depth of water of 9.25 m. at mean low tide. This jetty cannot be used by anything larger than a 25,000-ton tanker and is, indeed generally inadequate on account of its limited width.

In order to provide more up-to-date facilities, additional berthing accommodation for tankers has been made available in the North Docks of the port. This accommodation comprises a number of berths alongside mass concrete quay walls and furthermore six concrete jetties, the minimum depth of water in all cases being 11.75 m. The jetties, in particular, have been designed for use by very large tankers. They are of two types (Fig. 1 and 2) and were all constructed between 1951 and 1956. Those of type I are T-headed structures having a single approach, whilst those of type II are of somewhat later design and are each provided with three approaches.

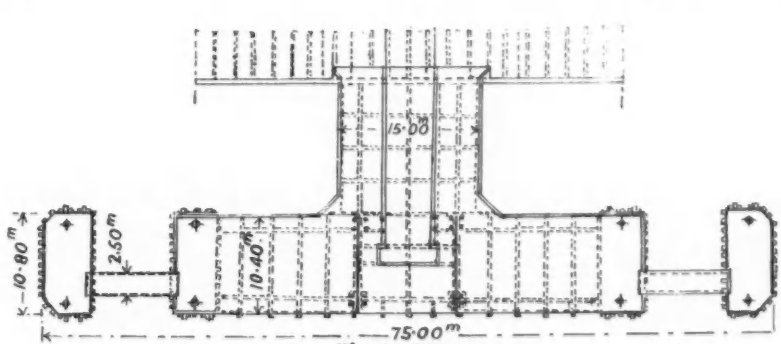
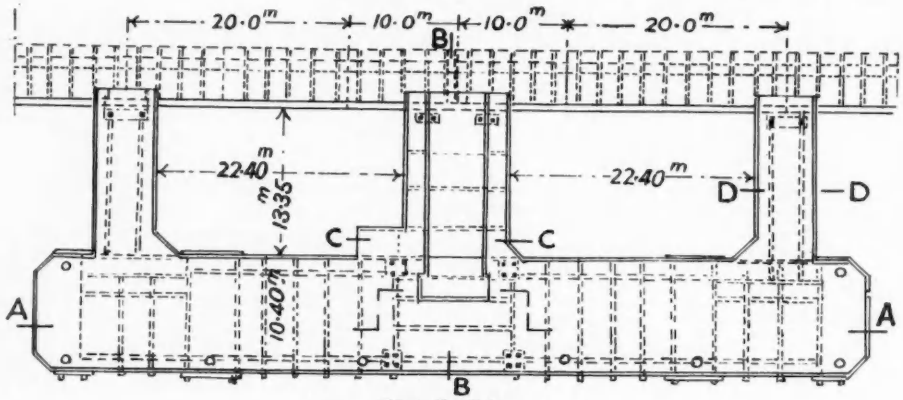


Fig. 1 – Plan.

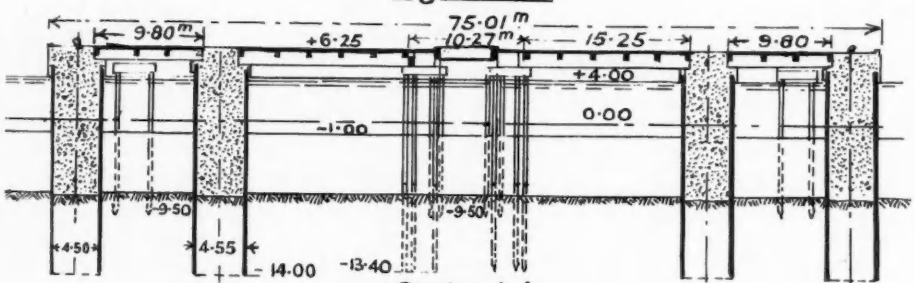
In all cases the jetty head is 75 m. in length and 10.40 m. in width. It consists of a reinforced concrete superstructure supported partly on piles and partly on massive piers of monolith construction consisting of steel sheet-pile cofferdams filled with Colcrete-grouted mass concrete. The 0.38 m. x 0.38 m. precast reinforced concrete piles are arranged in groups of two, four or six, surmounted by reinforced caps. The superstructure is constructed of precast units which were erected with the aid of a 150-ton floating crane.

The deck of the jetty has been designed for a uniformly distributed superimposed load of 1,000 kg/m² acting in conjunction with a live load equivalent to a 10-ton lorry. In the case of the type II jetty the central approach structure has been designed for a distributed load of 750 kg/m² plus a loading corresponding to a derrick crane (concentrated downward load of 10 tons at the base of the mast and an upward pull of 6 tons at each of

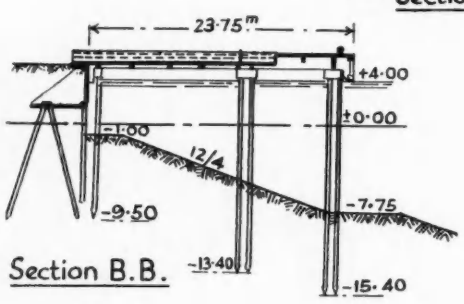
Berthing Facilities at Antwerp and Rotterdam—continued



— Fig. 2—Plan. —



— Section A.A. —



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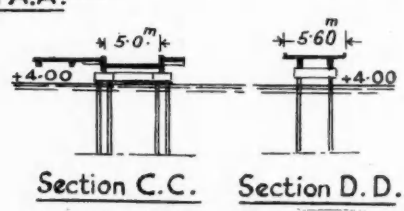


Section C.C. Section D.D.

the legs of the crane), whilst the two side approaches have been designed for a distributed load of 800 kg/m in conjunction with a 10-ton lorry.

The monolith piers are surmounted by bollards, each capable of resisting a pull of 100 tons, and are provided with oak fendering. Additional bollards are installed on the quayside; these ate embedded, behind the quay wall, in mass concrete blocks which are secured by means of tie-rods to a reinforced concrete anchor beam.

A number of large tankers—including the "Andreas V" of 34,000 tons deadweight capacity and a draught of 10.60 m. (35 ft.)—have used these jetties, which have proved entirely satisfactory.

The entrance to the Antwerp oil harbour has a width of only 35 m., so that it will not be possible to bring tankers of more than about 35,000 tons deadweight capacity safely into this harbour. To be able to accommodate larger vessels, up to 50,000 tons, it will therefore be necessary to build new jetties in a suitably accessible position. It is intended to construct these "as finger" type straight jetties placed at right angles to the shore line and capable of accommodating a vessel on each side.

For 50,000-ton tankers—which have a length of about 235 m. and a draught of about 11.60 m. (38 ft.)—such a jetty would have an overall length of approximately 360 m. The minimum depth of water to be provided would be 12.50 m. (41 ft.). The structure would consist, in the main, of a breasting island constructed as a rectangular concrete monolith of the type described above and having a length equal to at least one-third of the length of the vessel (i.e., about 80 m.) and a width at least equal to the width of the vessel (in the present case 30 m.). In addition, it would comprise a number of dolphins located on the centre-line of the jetty; these would carry concrete bridges connecting them to one another and to the breasting island and the shore. The use of rubber fenders is envisaged for these new jetties.

Rotterdam

The number of deep-draught vessels using the Port of Rotterdam has shown a marked increase in recent years. Whereas in 1950 only 12 vessels with a draught exceeding 10.50 m. entered or left the port, this number had increased to 150 in 1957. The maximum permissible draught of vessels navigating the New Waterway, which links Rotterdam with the sea, is about 11.30 m. (37 ft.) at the present time. This is not quite adequate for utilising the full carrying capacity of vessels of 47,000 tons deadweight. By the spring of

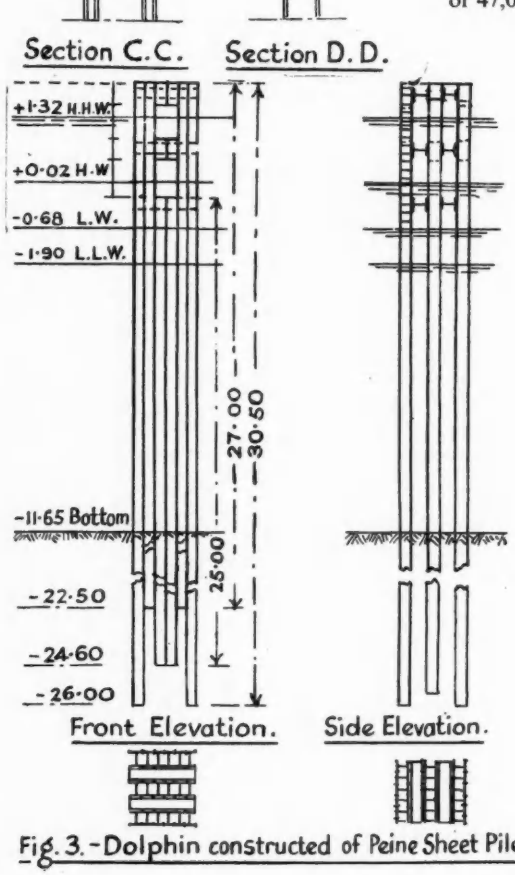


Fig. 3.—Dolphin constructed of Peine Sheet Piles.

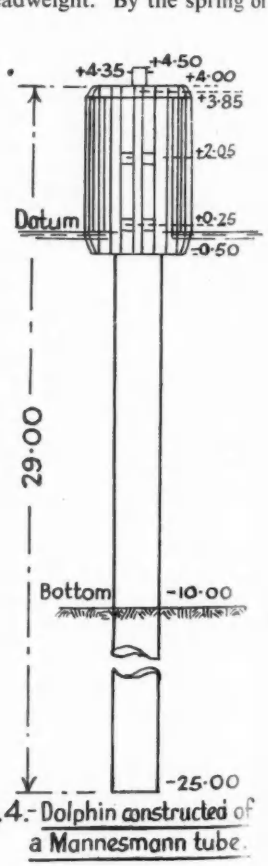


Fig. 4.—Dolphin constructed of a Mannesmann tube.

Berthing Facilities at Antwerp and Rotterdam—continued

1959, however, dredging of the waterway will have made the three oil harbours of Rotterdam accessible to vessels with a maximum draught of 11.90 m. (39 ft.). The depth thus provided will be adequate for fully-laden 50,000-ton tankers.

A start has furthermore been made with the construction a special new harbour—constituting part of the projected Europort scheme—which will be able to accommodate vessels of 65,000 tons deadweight capacity with a maximum draught of 12.80 m. (42 ft.). This harbour is due for completion in 1961. It will initially be accessible by way of a branch connection from the New Waterway, but will, along with the other harbours of the Europort system, eventually be linked directly with the sea.

All the oil harbours of the Port of Rotterdam have sloping banks, the tankers being berthed at jetties built out into the water. Most of these are of comparatively light reinforced concrete construction and are protected by heavy dolphins which are installed about 1.50 m. in front of the jetties and are structurally quite independent of the latter. The impact exerted by a 45,000-ton vessel striking such a dolphin with an approach velocity of 0.25 m/sec. will cause it to deflect about 1.00—1.20 m. but it will return to its original position when the impact energy has been absorbed. Fig. 3 shows a dolphin constructed of Peine sheet piles, its cross-sectional dimensions being 1.50 m. x 2.38 m. A different type of dolphin, with a shaft consisting of a 1.25 m. diameter Mannesmann tubular section, is shown in Fig. 4.

The berthing facilities for tankers envisaged in the Europort scheme will consist of "finger" type straight jetties, approximately 30 m. wide and spaced 140 m. apart. It is still being investigated whether they shall be entirely of rigid construction or whether they shall consist of three or four rigid monoliths connected by relatively light concrete bridging structures. It will in either case be necessary to provide very efficient fenders capable of absorbing a large proportion of the impact energy.

A Remedy for Dock Strikes

Correspondence on the Proposals by "Poseidon"

The following is a selection of further letters to the Editor which have been received since the publication of our November issue. They are written in reply to the article on "A Remedy for Dock Strikes" which appeared in the October issue of this Journal.

Sir,—I have read with very great interest "A Remedy for Dock Strikes" in your October issue and whilst, as you say in your Editorial, it is not to be expected that there will be full agreement with "Poseidon's" remedy, it is a good thing once again to ventilate publicly a state of affairs which has become such a continuing drag upon the country's maritime trade.

The principal argument in favour of action is of course the persistence of the problem. Ever since the war the docks have led the field in man hours lost per thousand insured persons—so easily that the rest have been left nowhere.

It is generally agreed that the basic reason for this chronic unrest is, as your correspondent suggests, the lack of a normal employer-workman relationship in the industry. In my Presidential Address to the Institute of Transport in 1956, I analysed the Reports of the Leggett and Devlin Inquiries on this subject and summarised them as follows:—

> "Leggett regards the creation of this relationship as the most effective step that can be taken towards a more stable and peaceful atmosphere in the industry; Devlin says that more than anything else it makes for peace in industry."

Your correspondent suggests as a remedy that there should be a single operational employer of dock labour in each port (two in London) and that the Dock Labour Board should cease to exist. Let us, Sir, be realistic. There is not the slightest chance that this Government or any other government in the foreseeable future will repeal the Dock Workers (Regulation of Employment) Act or alter radically the Scheme authorised by that Act. It is perfectly possible without contravening the main provisions of the Scheme to obtain a genuine employer-workman relationship. I suggested one such method in my Address and I have no doubt that other—and very likely better—ones can be devised.

There are however two conditions which are essential for this reform. First, that the employers must be willing to amalgamate their interests sufficiently to enable each remaining employer to give permanent employment to a large group of men; and second, that both employers and workmen recognise that casual employment is a relic of the bad old times of the industrial revolution, which in the end does not benefit either side of industry and should have no place in our ports to-day.

There is no sign that either employers or workmen are able to accept these conditions. I feel it to be a tragedy that so important a part of our national trade is operated under conditions which have been considered out of date for twenty years in most other industries.

It may be thought that I am over simplifying the problem. I know that a most complex series of operational and labour difficulties are present in the industry, but if the causes, real or nominal, of the major strikes since the war are analysed it will be found that they do in fact stem from the impersonal and impermanent relationship between employers and workmen. It is no use trying to patch up cracks in a house which is built on unsound foundations.

Treble House,
Blewbury, Berks. Yours faithfully,
18th November, 1958. FRANCIS H. CAVE.

Sir,—I was very interested to read the article in your October issue on "A Remedy for Dock Strikes." May I say first of all that I think your writer over simplifies this very difficult and complex problem.

The problem taken, as a whole, is a very old one indeed, it arises from the conditions in the docks one hundred years or more ago, and one cannot divorce past events from the situation to-day, despite the fact that the situation in the country, as a whole, has changed so much.

One must remember that it is impossible for a Minister of any Government to legislate to make a bad man into a good man. This applies to both employer and employee. It is, therefore, my opinion that to get peace in the docks, one must first try to work to the existing rules, which is not done, and then in the light of the experience gained, amend, abolish or, if necessary, make new rules.

It is common knowledge that the rules in the docks are constantly broken by both sides, I emphasise both sides.

The basic cause of the Dockland trouble is bad "industrial relationship." I think both sides would do well to set up some form of personnel officers, similar to the scheme which works very successfully in the Steel Industry. This is most important because of the complex situation that exists. In time the question of the single employer and the single unionist can be dealt with, but to try and do this at the present moment would only lead to unrest.

Having regard to the above, one cannot rule out the fact that the docks are one of the main targets of the Communists. I am not suggesting for one moment that they are the cause of the trouble, the causes are, I think, as I have already stated. The job of the Communist agitator, is to ferment these causes, he is not there to create them. It is, therefore, obvious that whilst this condition exists, the Dockland is a happy hunting-ground for this field of activity.

27, Brinklow Crescent,
Shooter's Hill, London. Yours faithfully,
5th December, 1958. H. B. W.

A Remedy for Dock Strikes—*continued*

Sir,—Although they will disagree with many of the statements and conclusions presented by "Poseidon" in your October issue, those who have a down-to-earth knowledge of the tangled problems of dock labour will be grateful to him for having provided an opportunity for public consideration of matters which, until now, seem to have been obscured rather than illumined, by the countless Committees of Inquiry, official and otherwise, which have reported during the last 35 years.

It is true that London and Liverpool together employ about 60 per cent. of the dock labour force, but no one can ever understand the overall national problems if they assume that these two ports are, in any way, typical of the country as a whole.

The causes of the present malaise differ from port to port and frequently take their origin in evils which were corrected when, following the Shaw Report, the first National Dock Agreement was signed in 1920.

Few dockers now working can have had much personal experience of work on the docks in the bad old days, but the evil that men did lives on, and it says little for the public relations work of either side of the industry that, although casual employment was abolished 17 years ago, recruits are still brought up on the sludge of memory.

A partial explanation of this lies in the fact that, for differing reasons, neither the employers nor the Unions have any liking for the National Dock Labour Board. The Employers consider that, as they provide the revenue, they should control the Scheme, while the Unions resent the developing interest of the men in the Board and its welfare activities.

The crux of the general problem lies in the employer-worker relationship. It is commonly believed that the Board has come between the dock employer and his men. Poseidon states that "until this relation is **restored,** there will be no peace in dockland" (the emphasis is mine) and immediately follows this with the bland statement that "It can hardly play a part in an industry where a man may work for half a dozen employers in a week."

In actual fact, in days of casual employment the majority of dockers (blue eyes and choice gangs excepted) had to seek work where it offered and so had no continuity of employment with any one firm. It must follow that, apart from any lack of desire on the part of the employers as a whole, there could not have existed the employer-worker relationship which Poseidon now wants restored.

This being so, it is clear that the Devlin Committee was absolutely right in dismissing the Employers' contention that the right relationship had existed prior to the Scheme.

The inescapable fact is that, with a few notable exceptions, the two sides were poles apart, the average docker loving his many employers with as much fervour as the miner did the colliery proprietor. How could it be otherwise? The majority of the 1,250 dock employers employed and still employ, dockers only as an ancillary part of their main function as importers, exporters, millers, merchants. They will only be concerned with dock labour when they have a ship alongside their wharf, and weeks may go by when they have no interest whatever in dock labour.

The only complete remedy would be the engagement of all men on a weekly basis, but few employers can foresee a sufficiently stable labour requirement to justify this, and the Unions are unlikely to agree to a hard core of permanent workers to be supplemented by "casuals" to meet peak requirements.

There is no restriction under the present Scheme preventing any employer from engaging on a permanent basis as many registered men as he wishes. The problem here is twofold: (1) the majority of the men prefer to remain as daily workers, and (2) the employer is unwilling to accept the financial obligation of maintenance when work is not available.

The labour requirements of the Port Authorities, Shipowners, Stevedores and Wharfingers fluctuate enormously from day to day and no scheme of decasualisation could survive the financial strain unless all the daily workers were available for employment by any employer.

The operation of the continuity rule is a vital factor in this field. These industrial rules normally provide that a man is entitled and required to work the job to its completion. This means that if on December 1st Tom Brown stands in front of Mr. X, the employer for whom he prefers to work, and Mr. X doesn't engage him, he is available for employment by any other employer in that port, or may be sent by the Board on daily transfer to another port. If this job lasts for six days, Brown will not be available for employment by Mr. X until December 7th, when exactly the same thing may happen.

Poseidon's remedy is a single employer (though London is to have two) who, amongst other advantages, would make the Board and the Scheme unnecessary. Let us examine the practical application of this specious submission.

The dangers of a monoply are so real as not to require argument, but does Poseidon really think that, short of an Act, any timber merchant would be prepared to hand over the labourage operations in his yard, including delivery to buyer's orders, or that waterside manufacturers would consent to their costly intake plant being operated by labour not under their control?

Not even Poseidon suggests that a return to casual conditions is practical or desirable, but it must be clear to all that a scheme of decasualisation could not survive in Great Britain except on the basis of a common levy and a national fund. The cost of operating a scheme without London and Liverpool would be quite prohibitive and, in the case of the small ports, might well exceed 100 per cent. of the wage bill—a swift and certain road to bankruptcy.

The only alternative would be the establishment of an organisation for the employment of all dock labour for all operations from Penzance to Aberdeen—a truly hideous thought.

This doesn't mean that steps ought not to be taken to reduce the absurdly high number of port employers, particularly those small stevedores who contribute nothing to the common good. However, a reduction of numbers will not of itself mean very much; in fact the Port of Manchester, where there has never been more than one employer, does not suggest that numbers provide an effective "Remedy for Dock Strikes."

Yours truly,

3rd December, 1958. "EMERITUS."

Deepening of German Ports and Waterways

The German Minister of Transport recently gave details of an important development programme for the ports and waterways of West Germany. The work, which will take several years to complete, includes extensions to the North Sea ports, improvements to the Kiel Canal and Dortmund-Ems Canal, canalisation of the Moselle from Koblenz to Diedenhofen, deepening of the Rhine fairway between St. Goar and Mannheim, the construction of further locks on the Neckar between Mannheim and Heilbronn, and the extension of large scale navigation on the river Main as far as Bamberg.

The Minister pointed out that the Dutch scheme for a new "Europort" at Rotterdam will compete with the German North Sea ports. It is therefore intended to deepen the approaches to Emden for ships up to 25,000 tons, to Bremen for 20,000 tons and to Hamburg for 40,000 tons. Wilhelmshaven is to be made accessible to the proposed tankers of up to 80,000 tons. To carry out the necessary dredging works, orders have been placed for two modern high-sea dredgers costing £1 million each. Some £8 million are to be spent on making the Kiel Canal available for ships up to 12 metres draught. To secure a draught of 13 metres would cost ten times as much.

The Dortmund-Ems Canal will be made available for 1,000 ton ships by next year, and the Mittelland Canal will be reconstructed to the same standard. The canalised Moselle will take ships of 1,500 tons.

On the Rhine, it is planned to provide 12 structures which will narrow the river and thereby deepen the fairway. These works will take five years. The proposed canalisation of the Upper Rhine is still subject to negotiations with Switzerland and Austria so that work is not likely to start before 1961.

The total cost of all these works is of the order of £100 million which must of course be spread over a number of years.

Ore Transfer Facilities at Contrecoeur, Quebec

New Canadian Transhipment Installation

By D. H. SHARP, M.E.I.C.,*
Assistant Manager, C. D. Howe Company, Limited, Montreal

DURING 1956, iron ore mined at Knob Lake by the Iron Ore Company of Canada Limited was shipped from their port at Seven Islands in ships varying in size from 9,000-ton to 45,000-ton ocean-going ore carriers.

The Seven Islands port opened on July 31st, 1954 and before the close of navigation at the end of November, had shipped 1,700,000 long tons. In 1955, 7,500,000 long tons were shipped, and in 1956, 12,000,000 long tons were shipped. The design capacity is 10,000,000 long tons. In 1956, 2,750,000 tons of this ore came up the St. Lawrence on its way to lake ports in the U.S.A. in ships too large to get through the canal system, and the ore was reloaded into smaller ships and railroad cars at the ore transfer facilities built for this purpose at Contrecoeur, Quebec; 2,206,000 tons were loaded into canallers and 460,000 tons into railroad cars, the balance of 84,000 tons remaining in the stock pile over the winter. These facilities are about 25 miles downstream from Montreal, on the south shore.

The facilities consist of a dock with capacity for unloading a 28,000-ton ship and loading canallers averaging 2,275 tons at the same time, or of loading two canallers at once if no large ship is berthed; two travelling unloading towers each equipped with a clamshell bucket capable of lifting 12 long tons of iron ore; conveying equipment to transfer from the unloading towers to a canaller loading tower and to railroad cars; and a storage pile area where the unloaders may place ore if no ships are available in which to load it. Provision is made to erect a 150-ton stiff leg derrick at the downstream end of the dock and for the loading of ships with it, should this be required. A small administrative office, machine shop and pump house are the only buildings.

An approach channel 300 feet wide and providing a minimum of 35 feet of water allows large loaded ships to berth. After they are unloaded and their draught reduced, they may turn around in the area between the dock and St. Lawrence river channel. Small ships, such as canallers have great freedom of manoeuvre as they are of very shallow draught and can approach without using the channel.

Unloading starts as soon as lines are made fast—the sequence of emptying holds being set by the ship's crew. The unloader tower operator has good vision into the hold and his rate of unloading is mainly governed by his dexterity. A 35 to 45-second cycle is maintained when unloading from ship to conveyor belt and a 55-second cycle when unloading to the stockpile. Before arrival of vessels, the aprons of the unloaders overhanging the water are raised to clear the ships' superstructures, and this is also necessary during unloading operations, to allow the towers to move past the superstructures to the forward hatches.

The clam shell bucket of 12 long ton capacity dumps into a 150-ton hopper over a 48 in. manganese pan feeder feeding the 36 in. dock conveyor. This conveyor in turn reloads on to an inclined belt feeding into the canaller loading tower. The ore is weighed on the inclined belt by a standard conveyor weigher.

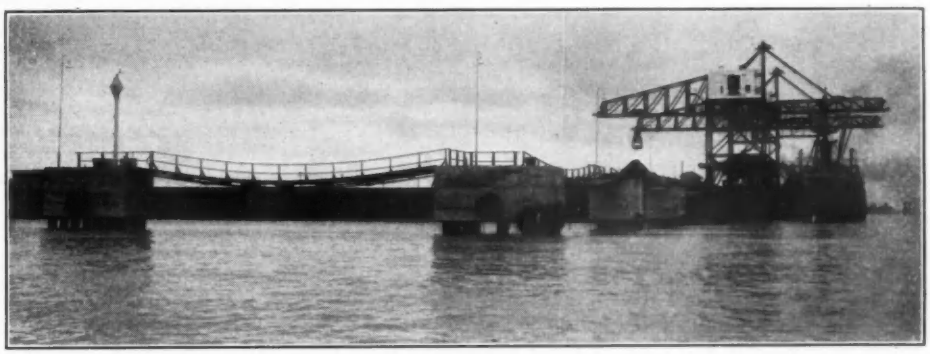
The canaller loading tower consists of a 42 in. retractable horizontal " shuttle " belt conveyor mounted on a moveable frame, motor-driven through a rack and pinion. All conveyors start and stop in sequence and are protected from being fed when not running at full speed by the use of centrifugal switches. The canaller is moved to maintain trim fore and aft as the tower is fixed. The shuttle conveyor may be moved while operating to trim athwart ship.

As the canaller is a small ship, loading with one tower at a time at maximum capacity (1,000 long tons/hour) is fast enough. Therefore, while towers are unloading freely, only one of them feeds the dock conveyor and the other unloads to the stockpile. During cleanup, when unloader capacity is reduced, both may feed the dock conveyor. Average capacity for unloading an ore carrier with properly designed cargo space is 800 tons per hour per rig. As soon as the large ship is unloaded, the stock pile is rehandled back to the dock conveyor. This arrangement is convenient and necessary since so many 2,200-ton canallers are required to equal to equal a 20,000- or 28,000-ton ship, and time must be available through use of a " surge pile " to allow for the arrival and departure of canallers and the moving of them during loading. In this way, unloading of the large ships may take place at maximum speed whatever is happening at the canaller berth.

The dock has three dolphins in line with its face on the downstream end, and one set back towards the shore at right angles with the others. Dredging has provided a turning basin here to receive the stern of a ship leaving the dock. The ship may warp downstream and pivot around the last dolphin with a line to the one ashore to assist the manoeuvre; this enables it to leave the dock heading upstream and at an angle to the current.

Should a ship wish to load at the 150-ton derrick, it may use the dolphins and the dock for mooring. A siding ends at the derrick so that cars, locomotives, and freight may be loaded. The siding connects with the C.N.R. track feeding Sorel from Montreal. A road runs parallel to the railroad siding part of the way, connecting the dock area to No. 3 highway. This road is at the same elevation as the top of the dock and has been run to the upstream and of the dock, so that its embankment will serve as protection against flood water which could otherwise flow behind the stockpile area to the railroad siding.

Water is pumped from the river and filtered and treated to provide the domestic supply for the small staff. A well was considered but the experience gained at a neighbouring property where brackish water and gas were encountered, was not encouraging. A prefabricated building provides office space, stores, and a small machine shop.



Looking upstream towards transhipment dock showing dolphins with connecting walkways and two shiploaders with ship at dock. Dolphins are designed to allow ship to drop astern, swing its bow ashore and thereby assist it in turning around to go back downstream.

The dock is of steel sheet pile construction, the unloading face being 751 ft. 5 in. long, piling being 83 ft. long and driven in clay with bands of sand. A rock blanket and gravel and sand filter are placed against it and the area behind filled with sand brought in from elsewhere. The piling is tied back with one row of tie rods.

Dredging of the channel and turning basin was done by a suction dredge with cutting head, the material being clay with some small boulders. This material was piled ashore downstream from the dock as it could not be used for fill. It was possible to walk on it shortly after it had been deposited.

Dolphins were constructed of groups of

* Reprinted from the January, 1957, issue of " The Engineering Journal," published by the Engineering Institute of Canada.

Ore Transfer Facilities at Contrecoeur, Quebec—continued

hollow piles, each made up of 3 steel sheet piles. These were encased in concrete caps 10 ft. thick x 20 ft. x 10 ft. and connected by tie rods, which also served to support wooden walkways connecting the dolphins. There is a bollard on each dolphin. The inshore dolphin is tied back to the downstream wing wall of the dock by cable. The river bottom was such that it appeared advisable to tie the dolphins together and to the dock.

Foundations for the 12-ton unloader rails consist of concrete walls on timber piling with cross wall ties every 25 feet. Foundations for the conveyors are spread footings on the rock fill and the administration and shop building (120 ft. x 40 ft.) is built on a monolithic reinforced concrete slab on fill material which was built up about a foot above the surrounding yard level. The storage area is of sand placed on clay. The 100,000 long ton storage area is permanently floored with a layer of lean ore about 2 feet thick. The elevation of this floor is about 2 feet below the yard level. A concrete wall separates the storage area from the dock area and also supports the steel structure supporting the power supply to the unloaders. Power for the project is received from the utility at 33 kv. and stepped down to 600 volts by means of a 2000 kva., substation. Three single-phase 667 kva., 33 kv., 600-volt transformers are used with a fourth spare transformer installed. Main low-voltage switching equipment and utility metering equipment consists of a switchboard located in a small prefabricated building adjacent to the transformers.

Each of the two unloading towers has two 300 h.p. W.R. bucket motors, a 150 h.p. W.R. trolley motor, two 40 h.p. W.R. propelling motors, a 5 h.p. S.C. rail clamp motor, a 60 h.p. W.R. apron hoist motor. In addition, each tower has an apron feeder powered by a 15 h.p. S.C.T.E.F.C. motor.

Power to both unloading towers is taken over a 3-conductor extruded aluminum system, each conductor being paralleled with a 750 m.c.m. copper booster cable, and the system rated 1500 amperes continuous. Power pickup to each unloading tower is by means of graphite collector shoes rated 1000 amp. for each conductor. In addition, each unloading tower has two control wires taken to it over a cable reel for sequence operation of the apron feeder.

The dock conveyor and inclined conveyor are equipped with 75 h.p. T.E.F.C. S.C. motors and fluid couplings. The dock conveyor is equipped with a thrustor brake so that its long decelerating time will not result in a pile-up of material at the transfer point.

The shuttle belt and shuttle transfer drives are also equipped with totally enclosed S.C. motors. The shuttle belt and apron feeders are equipped with traction type fluid couplings. All conveyors and the apron feeders are interlocked so that they may be started and stopped in correct sequence from the " all start—all stop " pushbutton in the ship loader. Double voltage relaying and centrifugal switch interlocks ensure that material will not pile up in the event of the failure of one drive. Each apron feeder may be stopped independently of the other conveyors from the ship loader.

Each conveyor and the apron feeders can be run independently of all sequencing from the " hand-off—automatic " selector switch near each drive motor. " Emergency stop " switches are placed at strategic locations along the various conveyors.

An 80-foot steel tower serves to accommodate flood lights for night operations. Floodlights on each unloading tower and on the ship loader supplement the tower lights.

The unloader towers are 91 ft. 6 in. high and about 30 ft. wide and are supported on dual 132 lb. rails. The total span of the arms is some 210 feet and the total lateral travel of the clam shell is 180 feet. The bottom chord of the arm is 62 ft. 10 in. above the rail, and vertical clam shell travel is about 90 feet. Bucket hoist speed is 308 feet per minute. Horizontal or trolley speed is 720 feet per minute, maximum.

The clam shell may be turned through 90 deg. by the operator to facilitate unloading from ship's hatches. The towers may be moved along the dock at 75 feet per minute and can approach to within 42 feet of each other. Bumpers are provided in case of collision. Warning horns sound while towers are travelling along the dock

Communication between the office and tower operator and other personnel is by radio. Loud-speakers are placed at the back and front, in the cab, machinery room, and at the hopper of each unloader, and at the reload point between the dock conveyors and in the canaller loading tower. All conversations are heard over all loud-speakers. A portable radio is used which allows the user to speak over the loud-speaker system, in which case he also hears his reply over the loud-speakers.

All hoisting and traversing machinery is housed in the towers on one floor about 73 feet above top of rail. One and one-eighth inch diameter steel wire rope is used and is bought on a large reel which is supported in the tower so that new rope may be fed off it into the rope system as required; the rope deemed unserviceable is cut off at the clam shell end. This saves replacing all rope when one spot becomes worn.

Bucket which lifts a nominal load of 12 tons of iron ore with clean-up Payloader suspended below it. This Payloader is lowered into the hold of the ship for clean-up purposes.

Canaller dock portion of the installation showing one loaded and one light canaller each about 2,200 tons capacity, 14-ft. draft. In the background is the bow of a large ship being unloaded at the main dock.

Hydraulic Model Investigation for Bridge in Iraq

Proposed Fallujah Road Bridge over Euphrates River

When investigating a problem at a particular site, it is often necessary to consider conditions some distance away. This is particularly so with hydraulic works. In the case of a hydraulic model investigation which the Central Laboratory of G. Wimpey & Co. Ltd. recently completed for Messrs. Rendel Palmer & Tritton, Consulting Engineers, for the proposed road bridge across the Euphrates River at Fallujah, 40 kilometres downstream of Ramadi, the details of the discharge upstream of the site are vital factors. The proposed bridge is located a short distance downstream of an existing bridge.

Problem of Flooding

The Euphrates River rises in the high mountains of Turkey and enters Iraq at Albu-Kamal. The whole effective catchment of the river lies in Turkey and Syria, and amounts to 110,000 square kilometres. In the past, the Euphrates River has been the cause of great flooding in Iraq, and has had a habit of breaking its left bank so that the flood water travelled across the desert and affected Baghdad. In 1929, the flood reached a flow of 5,200 cubic metres per second at Hit near the Syrian border.

By-Passing Flood Peaks

Since then, a barrage has been constructed at Ramadi, some 256 kilometres downstream of the Syrian border, to cut off the flood peaks and by-pass them into tho Habbaniya Lake which lies to the south of the river. This arrangement is designed to limit flood flows in the river downstream of Ramadi to 2,500 cubic metres per second and later, after the inlet channel has enlarged itself, to 2,000 cubic metres per second.

The Need for Research

It is necessary to dwell on these details of discharge because they have a most important bearing on the span of the proposed road bridge across the river at Fallujah. The purpose of the investigation carried out by the Central Laboratory was to check the adequacy of the proposed waterway for the new bridge and to verify that the proposed arrangement of piers, training works and protection, could satisfactorily cope with the flood discharges. If they proved unsatisfactory, modifications had to be sought.

Surveys Essential

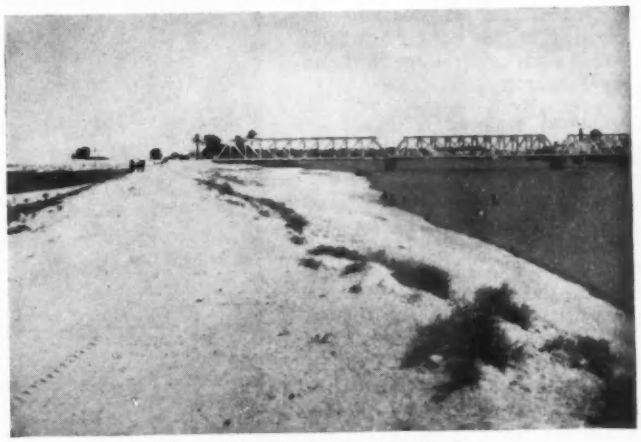
In investigations of this type, both topographical and hydrographical surveys of the site are essential factors and require to be carefully co-ordinated with borings and probings at selected positions in the river bed, in order to obtain a complete picture of the hydraulic conditions and characteristics of the river. It was necessary, in the case of Fallujah, to carry out the whole of this work during the month of August, 1957, when the river flow was expected to be at its peak for the year.

Collation of Information

A team from the Central Laboratory was sent out to investigate a length of five kilometres of the river which the bridge was to be located. The investigation included observations of 53 cross sections of the river, the determination of discharges and direction of currents, the installation and reading of temporary river gauges, the collection of samples of the bar sand, and the observation of attack points on the banks. In addition, scour and accretion tendencies in the neighbourhood of the proposed bridge piers were examined. The analysis of the mass of data accumulated was made back at the Laboratory.

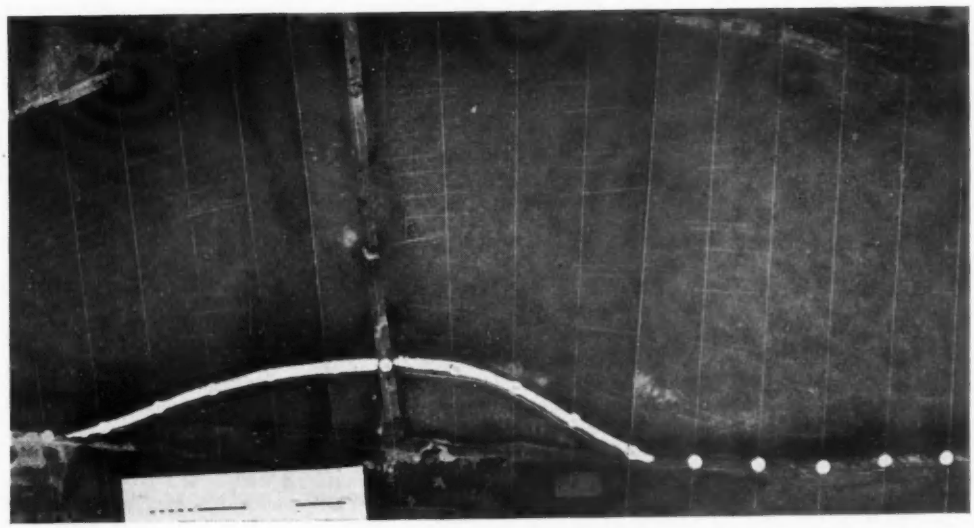
Reproducing Site Conditions

The next stage in the investigation was to design and construct the model to simulate the observed hydraulic conditions



The existing Fallujah Road Bridge.

Scour around Model of Pier for one of the Intensities of Flow (Scale 1/28).



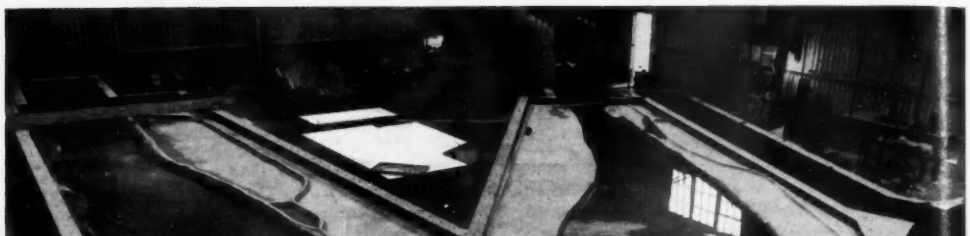
Direction and strength of surface currents at 3,000 cusecs. discharge in vicinity of Proposed Bridge (New Training Works on Right Bank shown in white).

Hydraulic Model Investigation—continued

and river bed characteristics. In this type of problem it is necessary to use a mobile bed type of model. The grading of the sand used in the bed of the model was identical to that which occurs in the bed of the Euphrates; the procuring in this country of sand having such a grading was no simple matter.

Horizontal Scale of 1/200

Lacey's principles were adopted in the design of the model; this involves the use of a distorted scale and exaggerated slope. A horizontal scale of 1/200 was adopted. The Lacey silt factor entered these computations and was calculated from the known slope of the water surface of the river between Ramadi and Fallujah; a value of eight centimetres per kilometre when the bank-full discharge of the river was 3,860 cubic metres per second.



A six kilometre reach of the River Euphrates reproduced to a horizontal scale of 1/200th. The sand islands seen in the upstream stretch of the river are exactly as plotted by the survey team.

The Three Stages

The model investigation was carried out in three stages. Firstly, the characteristics of the model were checked to ensure that they agreed with the conditions observed at site, over the full range of discharges. Having made certain that the model simulated the site conditions correctly, the second stage consisted of reproducing the characteristics of the great flood of 1929, but with an upper limit of 3,000 cubic metres per second because of the effect of the upstream control works. The bed profiles resulting from this flow were measured.

In the third stage, models of the proposed bridge and training works were constructed and the 1929 flood repeated to determine the effect of constructing the bridge across the river.

The Flume Model

In addition to the above model of the river, a model of a section of the bridge was constructed (to a scale of 1/28) in a flume, for the purpose of investigating the scour around the bridge piers. In the flume model, the intensities and depths of flow observed on the large model were repeated.

In these model investigations, the effect of two different overall spans and two different layouts of training works were investigated. The information obtained was essential for the satisfactory design of the project and was of a nature that could not have been obtained theoretically.

Self-Contained Roberts Current Meter

New Outfit for Measuring Direction and Velocity

The Roberts Current Meter is a self-contained current measuring device which can be left unattended while producing accurate records of current direction and velocity over periods up to a maximum of 14 days. The instrument records the current observations directly on a paper tape which can be removed from the buoy at intervals for interpretation on shore.

The Current Meter

The meter consists of a four bladed impeller revolving in bearings made of a new plastic, which wear well and have a very low friction when lubricated with water. The impeller is carefully balanced and carries one half of a magnetic coupling which drives a similar half coupling situated inside the meter casing, so that the internal mechanism is driven without the use of glands with their added friction and possibilities of leakage. The driven half of the magnetic coupling is mounted on a short shaft running in ball bearings, this drives through bevel gears and an intermediate shaft the large horizontal gear wheel of which revolves once for every five revolutions of the impeller. Situated below this large gear wheel is the compass element and at the top is the contact assembly. A cam fixed to a continuation of the compass axis above the large gear wheel causes the contacts to close once every fifth revolution of the impeller. Fixed to the face of the large gear wheel is a sun and planet gear arrangement carrying a second cam which is used to make the contacts close every tenth revolution of the impeller. This latter system makes contact when the cam is in line with the axis of the instrument, and, therefore, the instant of contact will depend on the direction in which the instrument is heading and so will give an indication of the direction of the current. Electric impulses — "pips" — are given every fifth revolution from the compass, which is fixed in direction by the earth's magnetic field, and also every tenth revolution, which are timed according to the heading of the meter. From these impulses it is possible to deduce the velocity and heading of the current.

The mechanisation of the meter is enclosed in oil in an inner casing which embodies a flexible bellows, thus ensuring that the pressure inside the casing is the same as that of the water outside, whatever depth the meter is suspended.

As the gear is unattended a good compromise must be chosen for the paper speed and duration of each recording. A paper speed of 2.5 cms. per second and a run of 30 seconds for each recording has been chosen for the meter, with recordings every 15 minutes. The paper runs for 2 seconds before the recording voltage comes on each time, so that there is a blank space of about 2-in. between recordings, thus making it easy to see where

Self-Contained Roberts Current Meter—continued

one recording ends and its successor begins. Because of these considerations the meter will appear to give zero water when the speed is less than 0.2 to 0.5 knots. After experience has been gained in actual sea conditions, however, it is possible to extract some information from records where the speed is lower than this.

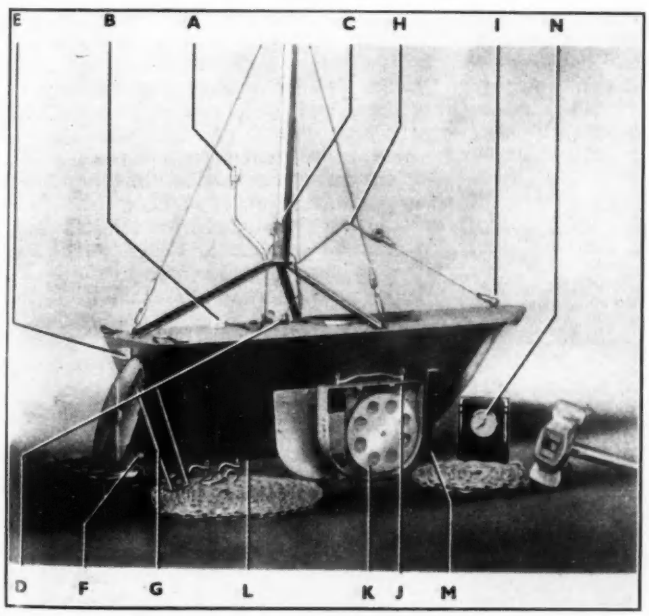
The Programme Clock

The programme clock is fitted into a mahogany box with the clock case mounted in a steel frame which is supported on the outer frame by four anti-vibration mountings. In the box is the master clock, consisting of a very fine lever clock which is electrically rewound every half minute. In the door of the clock case is a slave clock, which is driven through a relay by an impulse from the master clock once every second. This slave clock drives cams which control the recording programme, while the master clock gives the $\frac{1}{2}$ second impulses which, through a relay, make the 2 dashes per second on the recorder tape.

The Recorder

The recorder used is a development of the small single pen recorder used with the ordinary radio current meter, which utilises electric recording on Teledeltos paper. There are two pens, one fixed pen which marks the time dashes on the tape and a moving pen whose trace bears a jig when each impulse from the current meter is received.

The paper tape is drawn through the recorder at a constant speed by the action of a milled drum, against which the paper is pressed by a small spring-loaded wheel after it has passed under the pens and over the polished metal platen. The take-up spool is driven by a mechanism that permits slip so as to avoid breaking the paper and the feed spool is braked by a leather pad to avoid overrunning of the tape when the motor stops at the end of each recording. During the recording periods extending over 14 days, up to 3,800-ft. of paper tape is used.

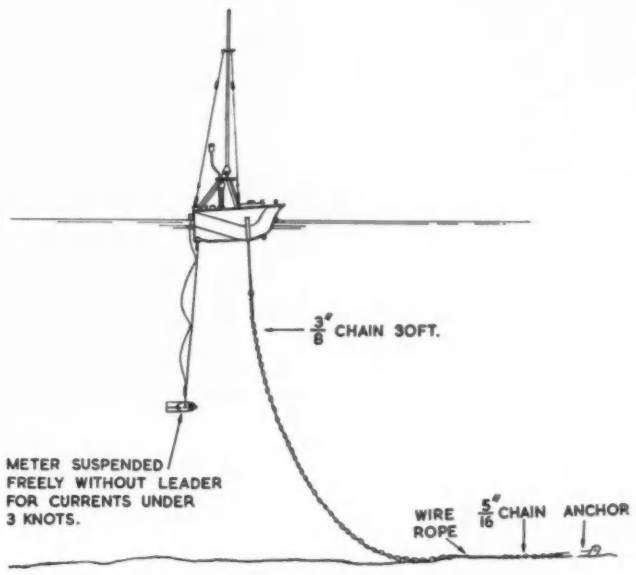


The buoy and its contents.

A - Riding light. B - Junction box for riding light. C - Vent pipe secured to mast. D - Gland for vent pipe. E - Junction box for meter connection. F - Ring for meter suspension. G - Frame for clamping batteries. H - Lifting device. I - Stay for lifting device. J - The recorder. K - Take-up spool. L - The mooring bridle. M - Mooring bridle pivot. N - Programme clock in frame.

The Buoy

The buoy which contains the recorder, programme clock, and accumulators is 120-in. long, and is constructed of mild steel plate and weighs 993 lbs. when empty, and 1,333 lbs. with contents. Carrying a wooden mast which is surmounted by a radar reflector, the buoy is fitted with a riding light in a dioptric glass. Inside the buoy a wooden deck carries the four 6 volt accumulators and the programme clock. The accumulators are



Mooring in shallow water.

clamped down, two on each side of the centre line, and when all four are connected in series they give 24 volts, while the recorder hangs in two anti-vibration mountings from a steel beam welded across the manhole.

The Moorings

Supplied with the outfit are 400 fathoms of $\frac{7}{8}$-in. steel wire rope, 15 fathoms of $\frac{1}{2}$-in. chain, 5 fathoms of $\frac{7}{8}$-in. chain, a 12 cwt. stockless anchor and shackles and swivels. In shallow water the scope should be about three times the depth and the stability of the buoy is improved if the $\frac{7}{8}$-in. chain is suspended below the mooring bridle. If the two lengths of chain are joined together with shackles and a swivel, the total length will be 20 fathoms and will thus be sufficient for a depth of 40-ft. For greater depths the length is made up by adding a sufficient quantity of the wire rope. In very deep water, over 100 fathoms, it is not necessary to have the $\frac{7}{8}$-in. chain suspended below the buoy. If for local reasons it is necessary to reduce the scope of the moorings it can be done by using a heavy concrete slab instead of the anchor, with 5 fathoms lengths of $\frac{7}{8}$-in. chain joined end to end. This arrangement is suitable for 6 or 7 fathoms depth as in an estuary.

Radio Current Meter

The Roberts Radio Current Meter is similar in many respects to the self-contained equipment but has the facility of transmitting the metered information via a radio link to a recording station up to twenty-five miles away. This equipment has now been supplied to a number of Authorities and is claimed to be one of the most accurate current meters available. The outfit can be supplied with two or three buoy units permitting simultaneous metering of two or three positions, or depths, the information being recorded on the one recorder which is a three channel receiver enabling switching to any one of the transmitters.

The Construction of the Volga-Don Canal

Completion of an ambitious scheme to link two great rivers

By JAC. de JONG, N.J.K.

IN so vast a territory as the Soviet Union, sufficient inland communications have always been a considerable problem. For many centuries the few highroads linking the major centres were completely inadequate and, in many places, the best way to travel across the great plains was to ride on horseback, or use the traditional troika during the winter months. The railways, too, were inadequate and, even now, according to recent accounts from those who have had the opportunity of travelling through the Union, they do not offer a comprehensive service.

An alternative method of transport for people and merchandise was by the great Russian rivers, although here, too, when waters froze during the winter months, there were many obstacles. The greatest difficulty in travelling on the rivers, however, was the fact that so few of them were connected in any way. This meant a costly transfer of passengers and goods at the river ports from water to land transport or vice versa, a process which, on certain routes, would have to be repeated so often as to make this mode of travel of doubtful value.

The urgent neccessity for more navigable waterways has always been evident to those Russians who have been in charge of the immense administrative system of the Soviet Union. Yet, although a certain measure of enterprise does not seem to have been lacking, economic and financial conditions were often so chaotic that very little was actually done to alleviate the traffic situation. The few canals in existence in Russia before the Second World War were constructed at the cost of great financial sacrifices compared with the actual improvements achieved. Most of the railways which had been constructed had been financed by foreign capital.

With the creation of the Union in 1918, the new Government were determined to improve internal communications as soon as possible in order to facilitate the growth of Russia's international trade. This reason (together with the desire to show the world something of Russian skill in hydraulic engineering) must have been in the minds of the Government when they finally decided, immediately before the last war, to go ahead with the execution of a scheme which seemed of primary importance even in the years of Russia's greatest depression.

The Sea of Tsimlyansk has transformed the Lower Don into an inland sea.

The plan was to link the Don with the Volga at a point where the two rivers come closest to each other. In this way it would be possible to open the landlocked Caspian Sea and connect it with the Black Sea, which is normally open to all international traffic. Russians in the past have referred to the landlocked Caspian Sea as an error of Nature, in that they considered that nature had made a grievous mistake in allowing Europe's largest river, the Volga, to discharge itself into the Caspian instead of into the Black Sea. However, the nearest point between the Volga and Don Rivers are only 33 miles apart.

History of the Canal

The first Czar to actively support the idea of a linking canal was Peter the Great, who invited a Dutch admiral, Cornelius Cruys, to make a professional survey into the possibilities of constructing a canal. Cruys compiled many plans, drawings and recommendations (they are still in one of the Leningrad museums) and the Czar subsequently had them examined by the Paris Academy of Science. The supervision of the work was entrusted to Brekel, a German who, unfortunately, knew nothing about the work. After a great many difficulties, one lock was at last completed, only to collapse the moment water was admitted into it.

In view of this disappointing result, the project was shelved for an indefinite time. In the period dating from the Brekel incident up to 1911 no less than 25 projects were submitted to the Government, some of them highly fantastic, but none was adopted. In the meantime, traffic using the Don and Volga increased every year and, in order to expedite the transfer of cargoes at the river ports, rails were laid, along which horse-drawn wagons hauled the goods from one river to the other. In a later stage, this intermediate transfer was carried out by the railways proper.

Just before 1942, the Soviet Government had a detailed scheme prepared and were about to start the preliminary work when the war intervened. The area which the new canal was to traverse became the site of one of the decisive battles between the Germans and the Russians. When General Von Paulus' 6th German Army left the Don at Kalatch to march on Stalingrad on the Volga, they followed the same route as the Russians had planned for their new canal.

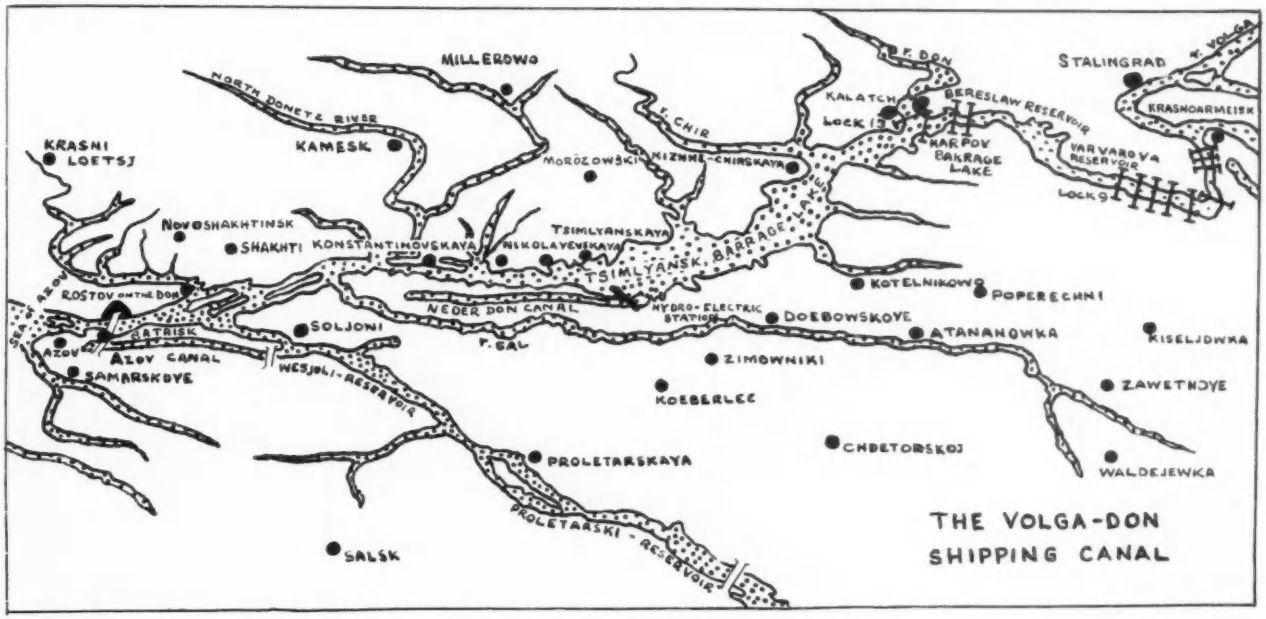
This picture gives an idea of what was involved in the construction. One of the hopper dredgers at work in the monotonous wilderness.

Construction of the Canal

After the war, work on the canal was commenced. Officially named "Volgo-Donskoy Sudokhodny Kanal imeni V.I. Lenina" (The Volga-Don Shipping Canal by name V.I. Lenin), the canal was inaugurated on July 27th, 1952. The rivership "Iosif Stalin", then the flagship of the Volga fleet, entered the first lock on the Volga side, watched by many thousands of people who had come to witness the event. It was the realisation of a long-cherished dream and was rightly considered to be a great achievment by the Russian people. This may partly account for the many triumphal arches, statues and marble-encased slogans that adorn some of the canal locks.

Preliminary surveys had established the fact that all the hydraulic works had to be constructed in soft, loose soil, which posed

The Construction of the Volga-Don Canal—continued



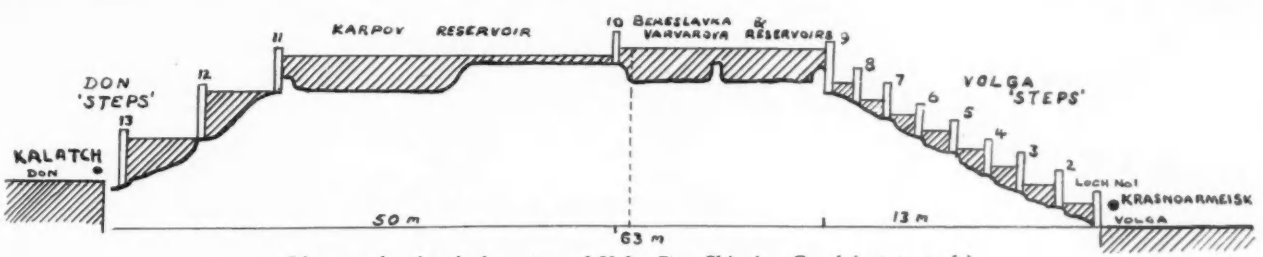


Diagram showing lock system of Volga-Don Shipping Canal (not to scale).

a number of problems. It appeared that the soil owed its peculiar looseness to the fact that many millions of marmots had been at work in it through the ages. Consequently the ground was seriously undermined, on a much larger scale even than was originally assumed. Many provisional embankments would suddenly collapse and ground water, too, proved to be persistent and required drastic measures to control it. The walls of the trenches frequently gave way and an intricate drainage system was necessary before the subsoil problem was at last effectively dealt with. It is reported that the water drained from the large trenches would have been sufficient to fill a lake of sizable dimensions.

The plan had a two-fold object. Not only was the all-important Volga-Don link to be made, but a hydraulic scheme was to be inaugurated which would irrigate the arid steppes in the great Stalingrad and Lower Don districts and so allow a greater agricultural production. With this latter consideration in view, the project had to involve a much larger area than was originally conceived, because the whole Lower Don district as far as the estuary at Rostov had now to be incorporated in the scheme. The distance between the two points farthest away, Rostov and Stalingrad, is about 300 miles.

The Lower Don project was started simultaneously with the preliminary excavation for the canal. In a stretch of the lower curve of the river (normally quite a wide stream already), the water was controlled by two huge barrage dams, the eastern dam at Kalatch where the new canal was to meet the Don, the western dam at Tsimlyansk, about 112 miles further downstream. The Tsimlyansk dam itself has a length of nearly eight miles and is served by a powerful hydro-electric station.

The lake has therefore a length of 112 miles and is in places almost 13 miles wide. In view of its size, it is better described as an inland sea and, in fact, the Russians refer to it as the Tsimlyanskoye Morye, the Sea of Tsimlyansk.

Meanwhile, good progress was made with the canal works, despite the frequent landslides caused by the unstable subsoil. It proved to be impracticable to make the link on a straight horizontal plan (i.e. covering the direct distance of 33 miles). Halfway between the two rivers there is a ridge some 330 ft. above the Volga level and, in order to bypass this formidable obstacle, the canal was planned L-shaped, the shorter leg to run in an almost north-south direction, and the longer leg to run west-north-west towards the Don. The total length of the canal is now about 63 miles.

The Volga at Stalingrad is nearly 66 ft. below the level of the Don at Kalatch. The exact difference between the highest and the lowest points of the canal is, however, 210 ft. of which the remaining 144 ft. are on account of an incline at Bereslavka/Varvarova, 13 miles west of the Volga terminus. Within this distance, the incline is negotiated by what is known as the " Volga steps ", a series of nine locks closely following each other, lifting the water from the low level of the Volga to the heights at Bereslavka/Varvarova, where two large reservoirs have been constructed.

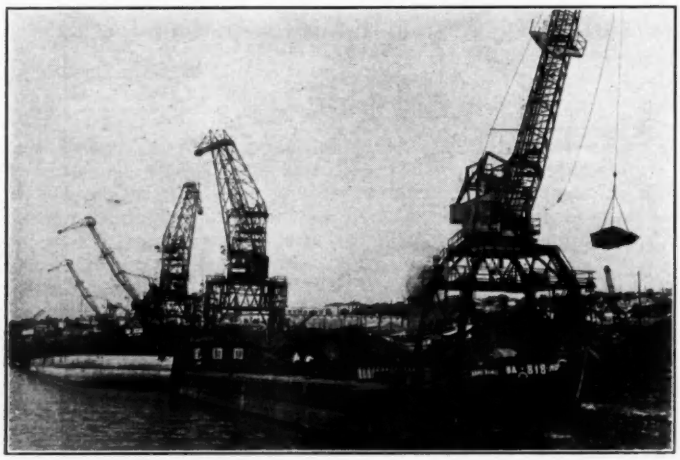
From there the canal runs due west for a distance of nearly 50 miles, passing one lock west of the Bereslavka reservoir and descending to the level of the Don via another three locks, the " Don steps ". The total number of locks used is therefore 13.

The canal joins the Volga at Krasnoarmeisk just below Stalingrad and it meets the Don at Kalatch on the north bank of the Tsimlyansk Sea. Towards the Don side, near Karpov there is within the body of the canal a third reservoir, the water for which is pumped from the Tsimlyansk just west of it. All the locks are wide enough to allow the usual type of Russian river barge or passenger ferry to enter with safety and, in the stretch between the respective " steps ", vessels have sufficient freedom in the wide reservoirs.

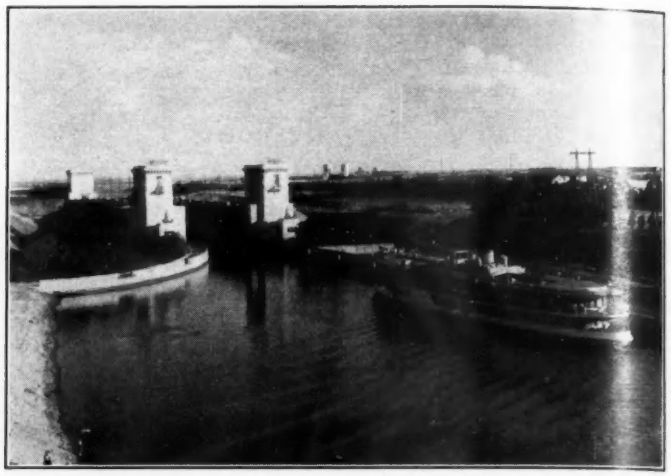
Construction figures

The canal took three and a half years to build and a feature of its construction was the extensive use of mechanised labour. Some 198 million cu. yds. of earth had to be

The Construction of the Volga-Don Canal—continued



Barges being discharged in the port of Rostov at the Don estuary, now made accessible to Volga shipping by means of the Lenin Canal.



The river-passengership Khirurh Vishnyevsky is about to enter one of the locks on the Volga side of the canal.

moved and nearly 4 million cu. yds. of concrete used in the various works. 45,000 tons of metal parts, apart from 16,000 tons of steel piling were employed and about 800 acres of ground had to be levelled.

Among the mechanical appliances used were some 350 excavators with an aggregate capacity of 70,000 h.p., some of the larger of which were equipped with grabs of 18 cu. yds. capacity. About 900 mechanical shovels, 300 bulldozers and 37 hopper dredgers, handling some 14,000 cu. yds. per hour, operated on the site and the spoil was transported by a fleet of over 5,000 vehicles assisted by cranes. On peak days, more than 700,000 cu. yds. of earth would be moved and almost 16,000 cu. yds. of concrete would be used.

It is estimated that the Tsimlyansk Sea holds 31 milliards cu. yds. of water, of which about 11 milliards is used yearly in the hydro-electric station. Apart from direct irrigation, the lake provides a constant high moisture percentage for the surrounding area, a fact which is of considerable importance to agriculture.

In the first year of operation, about 25,000 vessels passed up and down the Volga-Don Canal. Last year the number of boats which had passed through to date exceeded 200,000. Ports like Rostov, Kalatch and Stalingrad have become important transit centres.

It is likely that the importance of the canal will grow as Russian foreign trade increased, as it undoubtedly will do in the near future.

In such an event, transit ports such as Rostov will have to improve their road and rail connections with the hinterland in order to benefit to the full extent from their connections with the open sea.

Permanent International Association of Navigation Congresses

Excerpts from Annual Report of the British National Committee

The period under review in the report of the British Section of the Permanent International Association of Navigation Congresses is from December 1, 1957, to September 30, 1958.

The British National Committee has since the last Annual General Meeting in January held three meetings, and the main items of business dealt with are mentioned under separate paragraphs below.

A meeting of the Permanent International Commission was held in Brussels on June 24, 1958 and a full report of this meeting will be published in the Association's Bulletin in due course.

The meeting dealt with various routine matters including reports on new members; report by the Executive Council; financial returns and subscriptions; technical dictionary. The following items were also discussed:

XIXth Congress, London, 1957. The main items under this heading was the cost of the Congress borne by the Association (as distinct from the cost to the host nation). This amounted to 1,401,580 Belgian francs (about £10,000).

So far as the cost borne by the hosts was concerned it is anticipated that this will total about £20,000. This does not represent the actual cost since so much hospitality had been provided by the Government, Port Authorities, Corporations and other Organisations. The Institution of Civil Engineers had also provided accommodation and other facilities for the Congress and had made no charge. It is estimated that the cost of all these items amount to another £20,000.

It was reported that the XXth Congress would probably be held in the U.S.A. in 1961 but this has not yet been definitely decided.

International Commissions

(i) International Commission for the study of the standardisation of signals on navigable waterways in Europe. The Signals Commission has completed its work and its proposals have been largely accepted by the Inland Transport Committee of the Economic Commission for Europe. The Police Regulations Commission is continuing its work and two meetings have so far been held this year and one further meeting is scheduled.

(ii) International Commission for the study of depths in seaports. The International Commission to consider the Reports of the National Committees has not yet been set up.

(iii) International Commission for the study of the force of waves. The 1957 London Congress expressed the following wish in connection with Communication 1 of Section II (Ocean Navigation) of the Papers presented at that Congress:

"1. That the terms of reference of the 'Committee on the Force of Waves' be expanded to include the study of the following subjects:
   (a) the origins of long period waves so that their incidence may be forecast;
   (b) the disturbances (for example the frequencies and amplitudes of waves) which can be tolerated in harbours;
   (c) the mooring of ships in relation to such disturbances, and that the resources of the International Geophysical Year be used in connection with the first subject.
2. That the mooring of ships in harbours be considered as a subject for a future Congress."

One meeting of this Commission was held in June, 1958.

Permanent International Association of Navigation Congresses—continued

New International Commissions

The following Conclusions were passed in connection with Question 1 of Section II (Ocean Navigation) at the 1957 London Congress:

"1. That there is need for ensuring on an International basis the continuous exchange of information concerning common problems with, if possible, agreement on single or related matters aimed at facilitating the transport of cargo.

2. In order to meet this need, the Congress requests the Executive Committee to set up an International Commission to study in conjunction with other appropriate organisations where desirable the following subjects:
   (a) the provision and full utilisation of terminal facilities and appliances to ensure the speedy and economical flow of cargo;
   (b) improved methods of presenting general cargo for shipment by a utilisation of existing and new techniques so that such cargo is made available in the most economical number of units;
   (c) the principles governing the co-ordinate design of ships and conveyances with terminal facilities and methods of presenting cargo;
   (d) problems relating to the marking and packing of individual items of cargo.

3. That consideration be given to methods of further developing the joint approach of port workers and employers to measures designed to improve cargo handling."

At its June, 1958, meeting the Permanent International Commission agreed to invite National Sections to set up National Committees to prepare Reports. The British National Committee has in hand the setting up of the British Committee.

The following Conclusions were passed at the 1957 London Congress in connection with Question 2 of Section II (Ocean Navigation):

"1. There is an urgent need for joint study on the part of tanker builders and operators on the one hand and Port Authorities on the other, of certain problems relating to the maritime transport of oil.

2. To meet this urgent need the Congress requests the Executive Committee to set up an International Commission to study, among other subjects and in conjunction with other appropriate organisations, where desirable, the following subjects:
   (a) the impact factors involved in the berthage of oil tankers and the related berth design requirements;
   (b) the design and disposition of manifolds and hose-handling equipment both on the tankers and at the berths.

3. The Congress realises the need for continuing research on the following subjects:
   (a) measures to minimise the pollution by oil or ballast of coastal or harbour waters;
   (b) safety codes of practice for the prevention of fire at at oil ports and storage installations and in oil tankers;
   (c) ways of reducing turn-round time;
   and requests the Executive Committee to support strongly other organisations more specifically concerned with the formulation and promulgation of appropriate international standards."

At its June, 1958, meeting the Permanent International Commission agreed to invite National Sections to set up National Committees to prepare Reports. The British National Committee has in hand the setting up of the British Committee.

Bibliographical Documentation. The Executive Council were in favour of resuming the Bibliographical documentation which ceased in 1931. The British National Committee had already expressed the view that the labour involved in the preparation of these bibliographies—particularly in respect of the years since 1931—would not be worth while. The Committee pointed out also that the existing sources of information were considered adequate.

The Permanent Commission meeting agreed to the formation of a small working party to consider the matter. The view of the British National Committee that additional bibliographies are not worth the labour involved remains unchanged.

Proceedings of the XIXth Congress

The preparation of the Proceedings of the Congress has been entrusted by the British National Committee to an editing panel. The major portion of the text in English is now with the printers and work on the text in French is well in hand.

Multilingual Technical Dictionaries

Chapter I—The Sea—was completed during 1958 and has been circulated to members.

Chapter VI—Constructional Plant—work on this is in hand and it is hoped to publish it early in 1960.

Chapter IV—Boats and Vessels, Propulsion—work on this will be resumed when Chapter VI is ready.

The following Chapters are already available:
Chapter II—Rivers, Streams and Canals;
Chapter V—Materials;
Chapter VII—Ports;
Chapter VIII—Locks and Drydocks;
Chapter X—River Weirs;
Chapter XII—Maritime Signals.

Copies are available from the General Secretariat of the Association, 60 Rue Juste Lipse, Brussels, at the following prices:
Chapters II, VII, VIII, X and XII—100 Belgian francs.
Chapter V—200 Belgian francs.

Articles for the Bulletin

The Secretary-General has issued an appeal for Articles suitable for publication in the Bulletin of the Association. The British National Committee endorses this appeal and hopes that offers will be forthcoming from members.

Membership of the British Section

The present membership figures are: Life Members 47, Private Members 101, Corporation Members 73.

The arrangement whereby the Institution provides, without charge, the secretarial facilities for the British Section, and accepts payment of subscriptions to the Association for transmission in bulk to Brussels, has continued and is much appreciated.

Book Reviews

"Editorial Notes from Concrete and Constructional Engineering."

By H. L. Childe, 96 pages. Published by Concrete Publications, London. Price 7s. 6d.

The chairman of Imperial Chemical Industries, Ltd., has announced that, because of the poor quality of many of the young scientists and technologists applying for employment, his company is providing scholarships in technical subjects for men who have studied arts subjects only, in order "to provide a nucleus of really bright technical students." Lord Geddes has stated that technologists "rarely reach the summit in industry because they have specialised in technology to the exclusion of all other subjects." This problem is the subject of many of the 38 essays reprinted in this book. They relate specifically to civil and structural engineering, but apply to technologists in all industries.

The author's comments on the sayings and writings of technologists, some of whom are eminent in their professions, indicate the pitfalls that beset those who have not developed an inquiring and logical mind, and whose loose thinking results in statements that those who made them no doubt thought were profound truths but which are shown to be half-truths or nonsense—even when they appear in British Standards and Codes of Practice.

These examples, and the constructive advice throughout the book, are intended to encourage and help young technologists to write and say exactly what they mean, and particularly to pursue a course of study that will fit them for the higher posts that await technical men with more general knowledge and wisdom than their fellows.

Book Reviews—continued

The Pump Users' Handbook. By Herbert Addison, O.B.E., M.Sc., M.I.C.E., M.I.Mech.E. Published by Pitman and Sons, Ltd., Kingsway, London, W.C.2. Price 30/- net.

This Handbook has been sponsored by members of the British Pump Manufacturers' Association with the aim of offering direct help and guidance to owners and users of pumping plant. The term pumping plant covers a large variety of types and sizes of machine, capable of handling almost any kind of liquid, or liquid-solid mixture that can be made to flow at all, and this range of duties is expanding. The book is designed to help the men in actual responsible control of the pump; those who choose it, instal it and are involved in its operation.

Specific chapters have been devoted to the installation and performance of pumping plant and to the diagnosis of such infrequent troubles as may occur. Matters such as cavitation and pressure-surges, although complicated, have also been treated as it is esential that these dangers should be made known. As for the choice of a pump to meet particular conditions, the handbook offers selection charts based on possible types of machine and, also, includes a supplement which gives guidance in finding the names of makers who will probably be able to supply the pump indicated.

The author has had long experience of hydraulic machinery as a designer, user, research specialist and educationist and is, therefore, well fitted to compile such a handbook. It is not intended to replace makers' catalogues, or to give advice on commercial transactions, nor to compete with advanced treatises on pump design. Its purpose is to aid and guide owners and users of pumping plant and as such, should be useful to all those engaged in the industry.

Hydraulic Research in the United States 1958

Edited by Helen K. Middleton, National Bureau of Standards Miscellaneous Publication 224, issued August 15, 1958, 169 pages, $1.25. (Order from Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Foreign remittances must be in U.S. exchange and should include an additional one-fourth of the publication price to cover mailing costs.)

This publication, the latest in a series of annual publications dating back to 1951, contains reports on hydraulic research conducted within the past year in the United States and Canada. It serves as a guide in the co-ordination and planning of hydraulic research, and is a contribution to a broad effort to avoid duplication of research in the field. The information was compiled from reports by various hydraulic and hydrologic laboratories in both countries.

The project reports give the sponsor of the project, the nature of the work, a brief description of the process, the present status and results of the work, and any publications which have been written as a result of the project.

Each report bears an identifying number which it carries from issue to issue, as long as the project is active. In this way, the complete history of any project can be traced from inception to conclusion, even though it covers a number of years.

Further information on the projects can be obtained by writing directly to the organisation carrying on the project. For this purpose, full addresses of all co-operating laboratories are given.

Oil Pollution of the Sea

The manual on the avoidance of pollution of the sea by oil, first issued by the Ministry of Transport and Civil Aviation on October 31, 1957, has been revised in the light of the coming into force of the International Convention for the Prevention of Pollution of the Sea by Oil, 1954.

The purpose of the manual is to advise officers and men dealing with oil in ships, and those on shore engaged in the transfer of oil to and from ships, how spillages and leakages of oil into the sea can be avoided by the exercise of care and commonsense. It contains a summary of the prohibitions and requirements imposed by the Oil in Navigable Waters Act, 1955, and the Orders and Regulations made under the Act, together with a chart showing the zone of the sea around the United Kingdom within which the discharge of persistent oil by British ships registered in the United Kingdom is prohibited and a description of other prohibited zones prescribed in the Convention of 1954.

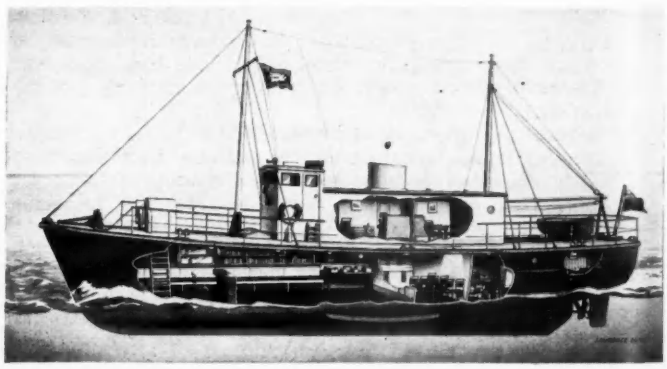
The annual can be obtained from H.M. Stationery Office or through any bookseller, price 1s. 3d. net.

Missions to Seamen's New Ship

Dedication of the "John Ashley"

The Motor Ship "John Ashley, built by John I. Thornycroft & Co. Ltd., was formally accepted by the Duke of Edinburgh on behalf of the Missions to Seamen, of which he is president, at a ceremony held at Westminster Pier on December 11th, 1958. The vessel will provide a new floating church and recreation room, for men who cannot get ashore from coasters and colliers at anchor in the Thames and Medway.

Accepting the builders' certificate the Duke of Edinburgh said that the name "John Ashley" had a particular significance to the Missions to Seamen because the present world-wide work among seamen of all races and nationalities owed its origin to the devotion and vocation of the Rev. Dr. John Ashley 100 years ago. "It was in this great port of London that the Society started its work, which has now spread to all parts and ports of the world. It is, therefore, I think appropriate and fitting that John Ashley should be commemorated in this way in this great port at the heart of the Society's work. It gives me very great pleasure to accept this new ship and wish everybody who sails and works in her and enjoys her the best of luck."



Cutaway diagram of the "John Ashley" showing accommodation.

After prayers by the Rev. Cyril Brown, General Superintendent of the Missions, the Bishop of London, the Right Rev. Dr. H. C. Montgomery-Campbell, dedicated the vessel.

The "John Ashley" is 75-ft. long, with a breadth of 18-ft. and a draught of 6-ft. 3-in. The deck accommodation consists of a wheelhouse and chartroom forward, with a padre's cabin and skipper's cabin immediately aft on the port and starboard sides respectively. In addition, there is a saloon, guest's cabin and toilet, as well as a 10-ft. dinghy on the deck. Below deck is the large recreation space to be used as a library, television room and cinema, with a door leading to a small chapel. The vessel is fitted with two Thornycroft type RNR6 diesel marine engines, each developing 90 b.h.p. at 1,600 r.p.m., giving a speed on trials of 10½ knots.

Deepening of the Suez Canal

It is reported that the Suez Canal is to be dredged to permit the passage of vessels having a draught of 37-ft. At the Authority's research centre at Ismailia studies are being undertaken of the currents caused by ships and their effect upon the canal banks.

Manufacturers' Announcements

New Range of Remote Control Equipment

A new, adaptable range of remote control push button equipment has been introduced by Dewhurst & Partner, Ltd., and is now available on an ex-stock basis. Equally suitable for such purposes as pump or machine tool control and lift or escalator operation, all items in the range are designed to conform to a new and flexible system—known as the "Dupar Unit System." This enables many different components such as push buttons, switches, round or rectangular indicator lamps, auxiliary contacts and audible indicators to be fitted into a control box of appropriate size. One of the features exclusive to this system is a wide selection of standard faceplate materials.

Four main type of control box are available in, at present, a total of twenty-five standard sizes. Briefly the four types are:—

(a) A pressed steel box with die cast ends suitable for all general purposes where a flush fitting faceplate is required.
(b) A one piece cast box fitted with oil seals, for use with oiltight components and a flush fitting faceplate.
(c) A surface mounting type for industrial or other uses, where a strong, compact, enclosure is required.
(d) A similar type to (c) but oiltight.

Also there is a tamperproof type of box which prevents unauthorised interference with the components and wiring.

The manufacturers claim that not only will the "Dupar Unit System" meet the requirements of almost every type of remote control application, but it is sufficiently flexible to embrace also non standard parts if these are needed.

A fully illustrated publication can be obtained, on request, from Dewhurst & Partner Limited, Inverness Works, Hounslow.

New London Showroom for Kelvin & Hughes Ltd.

A new London showroom and nautical chart department has been opened by Kelvin and Hughes (Marine) Ltd., in the recently built St. Clare House, Minories, London, E.C.3. The move from the old premises severed the Company's connection of over 100 years with Fenchurch Street.

Covering a total ground floor space of 6,500 sq. ft. in the new fourteen-storey building, the premises include a well-equipped

View of part of the new showroom showing the display of varied equipment

showroom devoted to the display of marine equipment. Displayed on one of the walls are examples from the various ranges of echo sounders manufactured by the Company. These are fitted as working installations, and an ingenious sounding board makes it possible to simulate the varying depths of water for demonstration purposes. Also displayed is the latest Type 14 Marine Radar, which is fed from an aerial mounted on the roof of the building and presents a P.P.I. picture of the surrounding area and the nearer reaches of the Thames.

The new premises include a chart correction department, where a stock of 50,000 charts, covering ports and trading routes throughout the world, are kept up to date. This department maintains a service which enables shipowners to obtain at short notice single charts or world outfits to special folio requirements, which can, if necessary, be sent by air to the ship's next port of call.

Yorkshire Engine Company Locomotives

The latest addition to the range of diesel shunting locomotives produced by Yorkshire Engine Company, Limited, Sheffield, is a 170 h.p. diesel-hydraulic design which was shown to the Press for the first time this month.

Yorkshire Engine Company's existing range includes 200,275 and 400 h.p. diesel-electric locomotives, which have been supplied to steelworks, chemical works, ports and other industrial users. The 170 h.p. diesel-hydraulic locomotive has been introduced with the object of widening the range to meet many applications in the lighter industries.

The new 170 h.p. diesel-hydraulic locomotive.

Developed in collaboration with Rolls-Royce, Limited, the 170 h.p. loco is fitted with a Rolls-Royce C6NFL normally aspirated oil engine, built at Shrewsbury, coupled to a Rolls-Royce twin disc torque converter, manufactured at Crewe. The engine is set in the frames at an incline so as to drive directly through the final drive, axle-hung gearbox. The gearbox has been designed in consultation with David Brown, Limited, Huddersfield, and Rolls-Royce, Crewe, and incorporates a double reduction transmission with power reversing. For normal duties, the locomotive is equipped with a CF converter, which simplifies the control equipment considerably and gives a sufficient range of speed with adequate performance for most industrial needs. In cases where a greater speed range may be desirable, however, a DF converter can be fitted as an optional extra.

The new diesel-hydraulic locomotive can be adapted to suit any gauge between 3-ft. and 5-ft. 6-in. and the overall height can be reduced to 9-ft. 10-in. for standard gauge or even less for narrower gauges.

The first of three 400 h.p. diesel-electric locomotives for export to British Guiana was also demonstrated. Based on the company's successful twin-engined "Janus" 400 h.p., six-wheeled, coupled locomotive, the new design has been adapted to a double bogie wheel arrangement for export purposes. The locomotives are required for the African Manganese Company's mining project in north-west Guiana, where a 3-ft. 6-in. gauge railway system is being built, extending approximately 30 miles from the mine to the river shipping station.

The maximum load to be hauled is 370 tons against the load where the steepest gradient is one per cent. Average speed will be about 14 m.p.h. with the loaded train. Maximum speed of the locomotive is 30 m.p.h.

Manufacturers' Announcements—continued

New Factory and Offices for Priestman Brothers

Priestman Brothers Ltd., recently announced the completion and occupation of their new works and offices at Marfleet, 4 miles east of Hull. The factory and office block is situated on the Hedon Road, alongside the River Humber and the deepwater docks. Housing the entire production of excavators, grabs and dredgers, it has 160,000 sq. ft. of covered area with 32,000 sq. ft. of office accommodation, and the total area covered by the site, which includes recreation fields, amounts to 40 acres. This compares with the 3½ acre site of the vacated Holderness Engineering Works, nearer to the heart of the city.

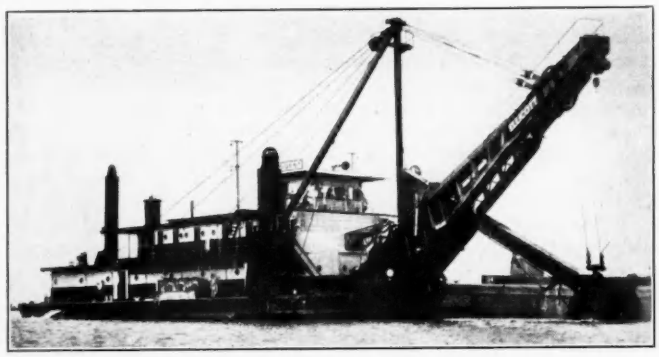
Aerial view of the new factory.

The buildings include a social centre and welfare block, housing the personnel department, a surgery and the works and staff restaurant, which is of wide single-span construction and provides accommodation for 550 employees at one sitting.

The main body of the works, which is divided into eleven bays, is dominated at the front by the office block. The framework of the latter is of reinforced concrete construction, and incorporates hollow tile floors and brick panel walls. Adequate space is still available for extension if required at a later date.

New American Dipper Dredge

A modern dipper dredge, claimed to be the first built completely as such in nearly 25 years was finished recently by the Ellicott Machine Corp., Baltimore, U.S.A. Constructed for the American Dredging Co. of Philadelphia, the " President " features several highly individual design items which greatly facilitate operational efficiency.



The new dipper dredge " President."

The dredger is not constructed simply as a dry-land machine mounted on a barge, but is designed entirely as a marine excavator. With a capacity of six cubic yards, it will dig to a depth of 47-ft. and will excavate blasted rock, boulders, compacted clay, and similar materials. The hull is 112-ft. long and 48-ft. wide and the boom, which is 60-ft. in length, can deliver the dredged material into dump barges moored alongside within a normal reach of 58½-ft..

Driven by a combination of diesel-electric power, the " President " is equipped with a General Motors 8-567-C diesel engine rated at 800 h.p. which supplies the electric current for operating the main machinery and auxiliaries. With such an arrangement, the variable power requirements function more easily and quickly than on units of this type operated by steam.

For manœuvrability and stability during dredging, the floating excavator is equipped with three spuds, two forward and one aft. The two forward ones are for anchoring in the bottom of the waterway and are raised and lowered by single drum winches, one starboard and one port, placed athwartship on the lower deck. The stern spud also operated by a similar winch has its point especially designed for trailing purposes.

Moving parts on the dredge have been kept to a minimum in order to reduce maintenance problems. But on the control stand, movability is a prime design feature. To provide the operator with complete visibility, the operating console is mounted on a track in such a way that it can move from side to side. On the lever stand are centralised all electric and air controls for one-man operation.

Film of the Port of Bristol

Shipowners and representatives of Conference lines were present at the Baltic Exchange, London early last month, for the showing of the Port of Bristol Authority's colour film " Bristol—Port of Many Trades." The film, which runs for about 38 minutes, describes the Port of Bristol's operations, its handling facilities and services for various trades. Recently the film was shown to representatives of non-Conference lines, and it will also be introduced to general traders.

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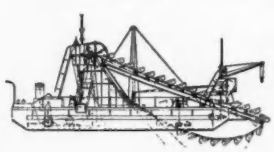

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